BRITISH TIMBERS

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BRITISH TIMBERS

OAK 'IN STICK'.

Photograph by N. C. Stoneham

BRITISH TIMBERS

THEIR PROPERTIES, USES AND IDENTIFICATION

With Notes on the Growth and
Cultivation of the Trees

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SECOND EDITION

WITH THIRTY-ONE PLATES
AND SIXTY DRAWINGS

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THIS BOOK IS PRODUCED IN COMPLETE CONFORMITY
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PREFACE TO THE FIRST EDITION

THE extremely important part played by home-grown timber in the world war has resulted in a revival of interest in our own woods, and an accompanying demand for information about them. It has been the object of the authors in writing this book to give, as far as possible, the known facts about the various timbers that are of practical value to the actual user, and also of interest and use to the student (whether with or without technical knowledge).

In any work dealing with home-grown timbers, details of the tree (where and how it grows) are of considerable significance. Firstly, the quality of the timber varies according to conditions under which the tree grew, and so a knowledge of trees is of the utmost value to anyone connected with the home-grown timber trade. Secondly, the landowners, who control most of the British woodland, whether they own five acres or five thousand, should know the most suitable trees producing the most useful timber that will thrive on their own land. For these reasons the present work deals with the characteristics of the trees in some detail.

The timbers are divided here for convenience into hardwoods and softwoods, and these again are subdivided into main timbers and those of minor importance. The latter category includes some species which are not very common at present, but have such useful properties that they will probably be used on a much larger scale in the future.

The growing tree is of such relevance to the timber that some space has been devoted to its sylvicultural and other characteristics. Brief notes are also included on methods of cultivation. It is hoped that this information will encourage and help the planting of the most useful trees that any set of conditions will allow to succeed. No attempt is made to cover the very wide and important subjects of forestry, timber structure and properties of wood. The intention is merely to give an outline of some of the more important aspects of British trees and timber.

We wish to express our sincere thanks to those friends who have helped us by providing specimens of timber. We would mention especially Messrs. John Sadd & Sons, Henry Longhurst & Son, and The Forest Products Research Laboratory. We also thank The Timber Development Association for some of the photographs used as plates.

75 Cannon Street, London, E.C.4.
May, 1943.

E. H. B. BOULTON
B. ALWYN JAY

PREFACE TO THE SECOND EDITION

IN this second edition we have endeavoured to increase the usefulness of the book by the inclusion of further data on the strengths of British timbers and on kiln-drying. Through the generous co-operation of the Director of the Forest Products Research Laboratory, and with the kind permission of H.M. Stationery Office, we have been able to include tables of strength figures and kiln schedules for the more important home-grown timbers. An appendix has also been added dealing with the fuel value of British timbers.

A number of alterations have been made in the botanical names of timbers, and we would express our indebtedness to the Director of the Royal Botanic Gardens, Kew, for a very considerable amount of help in this matter. Our thanks are also due to Dr. F. W. Jane and Mr. B. J. Rendle for kindly correcting the proofs and making valuable suggestions.

E. H. B. B.
B. A. J.

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BRITISH TIMBERS

CHAPTER I

BRITISH TREES AND THEIR CULTIVATION

Forestry, as a science, was almost unknown in Britain until comparatively recently. A few far-sighted landowners worked their woodlands on a definite thought-out plan, but in general the trees of Britain had to get on as best they could without any attention, unless they affected sport in any way. The 1914–18 war gave the first impetus toward a serious study of forestry, as it was then realised how vitally important home-grown timber supplies were. In 1919, H.M. Forestry Commission was formed, but with insufficient financial backing to undertake all the necessary planting to make good the heavy war-time felling and to increase sufficiently the forest-land of the country. The second world war has again emphasised the tremendous importance of there being the maximum possible supplies of good quality timber growing in the country, and there is every hope that the country as a whole will rapidly become forest-conscious.

In scientific forestry (or sylviculture) trees are treated as a crop, in the same way as an agricultural crop. They must be planted, tended, especially when young, and felled according to a definite plan. For this reason it is necessary to select species of trees that are of commercial value (except in the case of shelter-planting) and to select the most suitable species for any given area. In this selection a number of factors must be considered :

1. The value of the timber and possible market.
2. The size and form of the tree at maturity or at the end of the rotation.
3. Type of soil.
4. Climate, elevation, and aspect of the area to be planted.
5. Exposure to wind.
6. Amount of light necessary.
7. Danger from frost.
8. Rate of growth of tree and economic rotation.

It is important to use the right tree, or trees, since if this is not done, the result will not be really successful, no matter how carefully the woodland is tended. A number of trees will grow well for a period on almost any soil, but under unsuitable conditions will become unhealthy, or at least their rate of growth will decrease after about 20 years.

VALUE OF THE TIMBER AND MARKET

Valuable timber, such as good-quality oak or ash, can generally be grown with little regard for a local market, as the price will be sufficiently high to allow for transport to a considerable distance. On the other hand, poorer quality timber may not be profitable if a long transport to the nearest market is necessary. There is also the question of the disposal of thinnings ; these may be valuable for pit-props if of the right species and if the woodland is not too far distant from the mines.

With a long rotation it may not be possible to forecast the exact market in, say, 80 or 100 years' time, but fortunately the major markets tend to be stable.

SIZE AND FORM OF TREE

The ultimate size of any species of tree varies within fairly wide limits according to the conditions under which it grows, but it is usually possible to give maximum and average sizes under suitable conditions. Such figures are given in the descriptions of the trees included in this book. A knowledge of the size at various ages is desirable in order to gauge the volume of timber any given area will yield at different stages of development. By this means it is possible to determine the best time to fell, *i.e.*, to work out the economic rotation. For a limited number of conifers ' Yield Tables ' are available which give the number of stems and the volume of timber per acre at regular intervals (usually of 5 years) for different ' quality classes '.

The form of a tree can be controlled to a large extent by the forester ; thus when grown close together in woodlands, trees have longer and straighter boles and are cleaner (*i.e.*, have fewer branches) than those grown in the open. Some species, however, need very careful treatment to obtain the straight, clean, almost cylindrical bole that is the ideal, and expert knowledge of planting, thinning and even pruning is necessary.

A good indication of how successful a species may be is often given by the growth of the same

species nearby, but only mature trees can be regarded as really reliable guides.

TYPE OF SOIL

Trees do not impoverish the soil in the same way as agricultural crops; this is because the foodstuffs taken from the soil by trees are largely returned in the form of fallen leaves; also the roots of trees are usually left in the ground after felling and allowed to rot and add nourishment to the soil. It is for this reason that land can support continual crops of trees without manuring, and also that poorer soils can be used for forests than agriculture. Most conifers need less mineral constituents in the soil than broad-leaf trees and are generally used for the poorer types of soil.

Soil types may conveniently be divided into 5 main groups: (1) *Clays*, (2) *Sands*—comprising more than three-quarters by volume of sand, (3) *Loams*—mixture of about equal quantities of clay and sand, (4) *limey* soils, and (5) *peaty* soils. All these types may be modified according to the depth and amount of moisture.

Depth. It has been stated that 4 ft. of soil (including subsoil) is sufficient for all our forest trees Some flat-rooting trees are content with only a few inches, but normally the deeper the soil the better the height growth.

Moisture. The ideal soil should be moist all the year round, but in the case of very wet soils, suitable species may be selected (*e.g.*, alder), or the area may be drained. A wet soil, if of sufficient depth, is generally suitable for tree growth, but where stagnant water is present no tree will succeed. Dry soils may be improved by keeping a good cover of trees, so that the surface of the ground is protected from drying winds, and the fallen leaves prevent rapid evaporation.

In an established forest humus is of the greatest importance. It acts as manure, retains rainwater, and allows it to percolate slowly into the soil, improves the porosity of the soil and acts as insulation against cold and excessive heat. To retain and increase humus the overhead cover must be fairly dense; if too much sunlight can penetrate the wood, the fallen leaves (which form the humus) decompose too quickly, and the soil deteriorates. It is always wise to include some shade-bearers in any plantation as they shade the soil well; beech is an excellent tree for the purpose, especially as its heavy fall of deciduous leaves makes good-quality humus.

CLIMATE, ELEVATION AND ASPECT

Climate is even more important than soil, since poor soil with a good climate will grow far better timber than good soil with an unsuitable climate. Aspect and elevation greatly modify climate, although in this country elevation plays little part, as most of our forest trees will do well up to 1,000 ft. if soil and aspect are suitable.

EXPOSURE TO WIND

Generally speaking, trees that will withstand strong winds are those having a tap root, *i.e.*, a long main root growing vertically down into the soil. This form of root gives the tree a good grip in the ground. An exception is elm, in which the tap root usually decays, and so leaves the tree very liable to be blown. Trees such as cypress and spruces have a root system which does not penetrate very deeply into the ground, but spreads out in a wide, plate-like mass, and are known as flat-rooted trees. Broad-leaf trees are usually more wind-firm than conifers.

Areas swept by strong winds should be protected by shelter belts: these are best planted before the crop, and use may be made of any old existing trees. Evergreen trees are best, and they should be planted wide apart, at least 15 ft., in order that they may branch low down. Austrian pine is one of the best trees for the outside, and Corsican pine, beech and sycamore make an excellent mixture within the belt (which is ideally 40–60 yards wide).

LIGHT

The leaves of a tree must have sunlight in order to manufacture food for the growth of the tree; without light the tree dies. This natural law is utilised to obtain clean timber; trees are planted close together so that there is insufficient light for side branches to develop, and so that every tree struggles to outgrow its neighbour in order to reach the light. This results in long, straight stems with the branches confined to the top of the tree. If the struggle is allowed to go on too desperately, and for too long a time, the trees will become excessively long and thin (known as 'whippy') and the crown becomes so restricted that growth slows down. The amount of light is regulated, therefore, by thinning out a proportion of stems.

Forest trees may be divided into two categories according to the amount of light they need for successful growth:

1. *Light-demanders*—trees which will endure little, if any, overhead shade.
2. *Shade-bearers*—trees which may be grown under the shade of other trees; such species usually cast a dense shade themselves, and prevent undergrowth from developing.

There are also trees which come between these two types and are termed *moderate shade-bearers*.

Others will endure shade when young, but are intolerant of it when older. Certain trees will stand shade only under good conditions. Shade-bearers will always grow faster in full light.

In order to protect the soil, and also to obtain the maximum amount of timber from an area, a mixed wood is often formed consisting of a main crop of some light-demander (*e.g.*, larch) which is underplanted with a shade-bearer (*e.g.*, beech).

FROST

Early frosts, in the autumn, are not nearly so dangerous as late spring frosts which may kill trees by destroying the young delicate shoots. Thus trees which come into leaf late are less subject to frost damage.

The danger is greatest during the first few years' growth, until the young trees have grown above the frost zone—a layer varying in depth above the surface of the ground according to the contours. 'Frost pockets' are deep, narrow, and usually damp depressions or valleys; in these, even tall trees may be killed by successive years of frost damage. Only very hardy trees should be planted in such places. Hillsides and high land are most favourable and light soils better than clays.

Protection may be afforded young crops by planting a shelter wood (of so-called 'nurse' trees) some few years before the main crop. These nurse trees are scattered and of a hardy species which does not throw a dense shade; birch is often used. Existing trees may also be utilised.

RATE OF GROWTH AND ROTATION

The rate of growth is greatly influenced by external conditions—climate, soil, sylvicultural treatment, etc.—but when trees are described as fast or slow grown, it is to be understood that this refers to growth under good forest conditions. Trees do not grow at an even rate all their lives; some grow fast in youth and slow up in middle age; of others the reverse is true. These characteristics are important when mixtures are employed, to avoid one species killing out another by overshadowing it, due to its faster growth either early or late in life.

The economic rotation of a species does not necessarily represent its life, but in practice largely depends on the market. The ideal sylvicultural rotation, however, is that by which felling is carried out when the tree is mature, *i.e.*, just before the rate of growth begins to drop, due to old age; after this stage the tree begins to 'go back'.

CULTIVATION

Most forest trees are raised from seed, but a few, such as poplars and willows, are propagated by cuttings. The majority of broad-leaf trees will grow from cuttings, but seedlings generally form better trees; only a few species of conifers can be raised successfully by cuttings.

If only a small area is to be planted, young trees may be bought from nurserymen, but where the acreage is large, it is better to establish a nursery near the site.

Seed of most trees is sown in spring and the seedlings usually transplanted once or twice to improve the root system. This transplanting is very important and the number of years the plant spends in the nursery lines, how often and at what ages it is transplanted should be carefully controlled, according to species.

Plants that have never been transplanted are called seedlings; transplants are described by a kind of formula, *e.g.*, 1 yr. 2 yr. or 1 yr. 1 yr. 1 yr., etc.: these simply indicate the number of years the young trees have spent in the nursery and transplant lines. For instance, a '1 yr. 2 yr. transplant' means that when the seedling was a year old it was transplanted and left to grow for two more years; 1 yr. 1 yr. 1 yr. transplants have been twice transplanted, at the end of two consecutive years.

For planting out in the forest, the most generally used are 2 yr. 1 yr., 2 yr. 2 yr., and 1 yr. 2 yr. transplants. These are tall enough to avoid being smothered by weeds, and young enough to become quickly established. Planting out is carried out in open weather between the middle of November and the middle of April. As a general rule, broad-leaf trees are best planted in the Autumn, and conifers in the Spring.

NATURAL AND ARTIFICIAL REGENERATION. In Britain most new woodlands are formed by planting out of nursery-raised young trees; this method is called 'artificial regeneration'. Occasionally, when a wood is felled a few scattered 'seed trees' are left; the seed from these is carried by the wind over the area and a new crop is formed by 'natural regeneration'. This method has been little used owing to the depredations of rabbits, which kill the young seedlings. It is nearly always necessary to surround a plantation or area to be naturally or artificially regenerated with rabbit-proof fencing, to ensure success.

CLEANING. During the first few years of growth, the young plantation should be cleaned of weeds. To save expense and also to afford added protection to the young plants the weeds need only be cleared from immediately around

each plant, so that it has its head free. Care should be taken to keep trees free from climbers, such as honeysuckle, etc.

THINNING. When the plantation has reached the ' pole ' stage (usually at about 15–20 years) some stems will have to be thinned out to provide adequate growing space for the rest and to promote more rapid growth. The golden rule in thinning to obtain even growth and well-shaped healthy trees is ' begin early and thin lightly and often '.

PRUNING. Some species of trees retain their branches, even when dead, for a number of years, *e.g.*, Douglas Fir. To overcome this trouble a selected number of the best stems, which are to form the final crop, may be pruned early in life.

CLASSIFICATION AND NOMENCLATURE

Commercially, timbers are divided into two main categories: *hardwoods* and *softwoods*. Fortunately this system is based on botanical classification.

HARDWOODS belong to the great group of plants known as the *Angiosperms* and to its subdivision the *Dicotyledons*, commonly called the broad-leaf trees (and including evergreen and deciduous species). The angiosperms are botanically characterised by always having their seed enclosed in a seed case.

SOFTWOODS belong to the smaller group, *Gymnosperms* (in which the seeds are naked, without seed-case) of which they form the order, and the *Coniferae* or conifers, so-called because their seeds are collected together in cones.

Whilst it is true to say that softwoods, as a whole, are actually softer and lighter than hardwoods, there are several exceptions, for example, yew is far harder and heavier than poplar or lime.

A number of systems for the classification of plants have been devised by botanists, but the following short table illustrates the broad principles of classification, using common oak as an example :

KINGDOM—Plant
DIVISION—*Spermatophyta*
SUBDIVISION—*Angiospermae*
CLASS—*Dicotyledoneae*
ORDER—*Fagales*
FAMILY—*Fagaceae*
GENUS—*Quercus*
SPECIES—*Q. Robur.*

Plants are classified according to the characteristics of the plant as a whole, especially the structure of the flower. For this reason there is often a wide difference in species of one family, for example, the family *Rosaceae* includes small herbaceous plants such as the strawberry, and also trees such as cherry, apple and pear.

Every known plant has a botanical name, which is in two parts, giving its genus and species, *e.g.*, *Quercus Robur*. The name of the botanist responsible for the classification is also usually given and is often abbreviated: thus the full description of oak becomes Common Oak, *Quercus Robur* L. (a contraction of Linnaeus).

The trade name of a timber is not necessarily the same as the vernacular name of the tree, *e.g.*, the timber of Norway spruce is known as ' Whitewood ' or ' White deal '. This practice is less marked with home-grown woods than imported timbers.

CHAPTER II

THE PROPERTIES OF WOOD

The following notes are given with the intention of providing the reader with a background of general principles regarding the properties of wood and its utilisation. For ease of reference, the order and wording of the headings of the paragraphs which follow are the same as those used in the descriptions of individual timbers, in the body of the book, with the exception of the first, which follows on the main heading ' Timber ' in the descriptions.

GENERAL PROPERTIES

SAPWOOD AND HEARTWOOD. The sapwood is the younger growth of timber, situated nearest the bark. Its cells are actively employed in the conduction of sap up the trunk, and also in the storage of foodstuffs. It varies in colour and width according to differences of species, age and conditions of growth. Thus a wider sapwood is generally found in trees growing in the open than those in close forest.

Heartwood is usually darker in colour, and its function is purely to give mechanical support to the tree; for this reason a tree may lose all its heartwood and become hollow, and yet grow quite healthily. The pores often become blocked, and the remains of stored foods may be converted into tannins, etc. The heartwood may be

sharply defined from the sapwood (*e.g.*, elm and larch), may merge gradually with it or show no difference (as in poplar, alder, spruce, etc.).

There is no difference between the weight of sapwood and heartwood, and tests have shown that there is usually no significant difference in strength. The most important distinction is that the sapwood is usually far less durable; the foodstuffs (mainly starch) in the cells provide suitable food for both fungi and insects; the Lyctus beetle, for instance, confines its activities entirely to the sapwood. To compensate for its inferior durability, the sapwood is more permeable to preservatives.

COLOUR. Generally colour in timber is due to infiltrates in the cell-walls. Some of these infiltrates change colour on exposure to light, air or heat; this results in some timbers becoming darker on exposure (*e.g.*, alder) and others lighter, whilst some change colour altogether, *e.g.*, red cedar changes from red-brown to grey.

Kiln seasoning darkens some woods, due to the effect of steam; this is utilised to obtain an artificially darker colour in beech, sycamore and walnut sapwood, by treating them with a special steaming process.

GRAIN. The meaning of the term 'grain', which has been somewhat vague in the past, has now been standardised by timber technicians as the direction of the fibres relative to the axis of the tree. Thus such terms as 'edge grain' and 'flat grain' are confusing and should be changed to 'quarter sawn' and 'flat sawn'. The term 'grain' should not be confused with '*texture*' (see below). Straight grain is self-explanatory, and timber of this description is best for strength and ease of working.

Other types of grain are:—

Irregular grain. Where the fibres are at varying and irregular angles to the axis of the log. It produces *blister* and *bird's-eye* figure.

Spiral grain. The fibres follow a spiral direction round the axis. This is common in sweet chestnut, and reduces its strength considerably.

Diagonal grain. Tapering trees converted parallel to the axis of the trunk contain this defect.

Interlocked grain. The fibres of successive growth layers are inclined in opposite direction. This is an uncommon form in temperate timbers, but very common in tropical hardwoods. It results in *ribbon*, *stripe* and *roe* figures, all of which are difficult to work to a clean finish.

Wavy grain. The direction of the fibres is sharply wavy. *Fiddle-back* or *ripple* figure is the result; this is common in sycamore.

TEXTURE. This term varies from 'grain' in being descriptive, not of the direction, but the *size* and *variation in size* of the cells of a piece of timber. Thus oak is called 'coarse textured' (not 'coarse grained') owing to the large size of its pores, and box or birch 'fine textured,' for the opposite reason.

In softwoods the texture is almost entirely the variation of the thickness of the cell walls and the amount of spring and summer wood; Douglas fir is, therefore, called uneven textured and cedar (*Cedrus*) even textured. Hardwoods (especially of the diffuse-porous type) may be even textured.

FIGURE. The pattern on the surface of a piece of timber is called its 'figure'. The pattern may be due to the arrangement of the cells, nature of grain or variation in colour. Various figures are maintained under the heading of 'grain', differences of which are the most general cause of figure. There are a large number of different types of figure recognised in the trade, but space will only permit of the addition of two more. *Burr figure.* A burr is an abnormal, protuberant growth on the trunk and consists of a number of dormant buds which grow in thickness but do not shoot. When cut across, the burr results in a high figure of the bird's-eye type. *Crotch.* Timber taken from a fork or junction of trunk and branch gives this figure which is due to crowding of the tissues in the fork, producing a figure which is so well known in mahogany, but also sometimes found in forked, home-grown trees.

WEIGHT. As a general rule the strength of timber is proportional to its density which corresponds to its weight (density equals the weight divided by the volume). This is not always the case, as it has been shown that the chemical composition of the wood and the distribution of cells modifies this rule to a certain extent.

The weight of a timber depends on the amount of moisture contained in it; thus green poplar at 145% moisture content weighs about 55 lbs., but when seasoned to 15% weighs only about 28 lbs. For this reason weights given in this book are for a standardised moisture content of 15% (for definition of 'moisture content' see under *Seasoning*).

To calculate with reasonable accuracy the weight of a timber within a range of about 5% and 25%, given the weight at a moisture content of 15%, the Forest Products Research Laboratory give the formula: add or subtract 0·5%

of the given weight for each 1% moisture content above and below 15%.

DURABILITY

By durability is meant resistance to attack by timber-destroying fungi and insects. Mechanical wear is not included under this heading.

It is well known that some timbers, for instance oak and yew, are naturally more durable than others, such as poplar and spruce. Hardness is not always associated with durability, thus red cedar (*Thuja plicata*) has a far higher resistance to decay then the majority of timbers which are much harder. The actual reason for the durability of individual species is not clear in all cases; in the case of red cedar the presence of an aromatic oil is responsible. Resin and tannin also play a part as natural preservatives.

RESISTANCE TO WOOD-ROTTING FUNGI

A high resistance is only of importance if timber is to be used exposed to the weather or in a situation where there is a chance of it becoming damp. It has already been mentioned that sapwood is usually less durable than heartwood; but the degree of resistance also varies to a small extent according to position in the tree, *e.g.*, nearness to the pith, distance from the butt, etc.

Fungi are a group of plants characterised by a complete lack of chlorophyll, which necessitates them feeding on organic material. There are four essentials of life for a fungus :

1. Available food supply, *e.g.*, wood.
2. Adequate moisture; timber with a moisture content of less than 20% is immune.
3. Oxygen. Timber hermetically sealed is immune.
4. Suitable temperature; not really significant in this country as wood-rotting fungi can live in most temperatures reached. Growth is, however, greatly reduced in very cold weather.

Some fungi attack the timber of living trees; most of these, however, die after felling and seasoning. More dangerous species attack felled timber. Whilst drying timber to below 20% moisture content inhibits fungal growth, it does not kill the fungi, and if the timber becomes damp the fungus present resumes its attack. Kiln seasoning does kill the fungus, but does not immunise the timber from attack from outside sources if conditions become favourable.

The most dangerous fungi attacking timber in buildings are those causing dry rot. The chief of these is *Merulius lacrymans* which has the power of producing thick strands which can pass over and even through, mortar, brick, etc., to seek fresh wood to attack. Water is carried in these strands, and any dry wood can be moistened and then attacked.

Wood attacked by dry rot becomes soft, dry and powdery, and brown in colour when the damage is complete.

The best method of prevention is to keep the timber dry by sound construction, good ventilation, etc. Cure may be difficult, but the following general rules should be observed :

(*a*) All affected timber should be removed and burned.

(*b*) Walls and other materials other than timber should be sterilised with a blow-lamp or an antiseptic.

(*c*) Sound (or apparently sound) timber should be treated with a preservative.

(*d*) New timber introduced should be first treated with a preservative.

SAP STAIN. Certain fungi (of the 'mould' class) inhabiting wood feed only on the contents of the wood cells, and do not attack the cell walls. These are only found in the sapwood and do not affect the mechanical properties of the timber, but discolour the surface. The 'blueing' of softwoods is one of the commonest of this type of stain; it is caused by *Ceratostomella* spp.

Although not actually reducing the strength of timber sap-stain fungi spoil the appearance and may show through paint finishes. The trouble can be largely eliminated by rapid conversion after felling and by putting sawn timber in stick straight off the saw and inducing rapid drying by good ventilation.

RESISTANCE TO INSECT ATTACK

There are far fewer species of insects attacking British timbers than there are fungi, but, nevertheless, a considerable amount of damage is caused, and most timbers are susceptible to attack.

The most dangerous insect pests are beetles (*Coleoptera*), of which the worst are the Furniture, Powder Post and Death Watch beetles. In the case of beetles, the main destruction of the wood is due to the larvæ (with the exception of Pinhole borers) which tunnel through the timber, feeding on the wood tissues as they go and finally pupating near the surface; the perfect beetle then bores its way out. The so-called 'exit holes' are familiar in old furniture, and known as 'worm holes'. The beetles are able to fly and so can lay their eggs on timber remote from the affected wood.

FURNITURE BEETLE (*Anobium punctatum*). This beetle damages seasoned softwoods and hard-

woods; in beams, etc. it is usually confined to the sapwood, but may penetrate the heartwood in smaller sizes of timber, *e.g.*, furniture, etc. It is common in old floors, panelling, furniture, etc. The adult beetle emerges between June and August and lays its eggs in cracks or rough places in wood; the larvæ bore for 1–2 years before pupating. The galleries are filled with granular dust and the exit holes are about 1/16th in. across. Control is by avoiding sapwood where possible or by repeated treatment of affected timber with preservatives.

POWDER POST BEETLE (*Lyctus* spp.). There are about six species of *Lyctus* beetles, all of which are dangerous. The sapwood of certain hardwoods (especially oak, elm and ash) is attacked. Affected wood may be reduced to powder with a thin skin of wood which hides the damage. The larvæ feed on the starch in the cells, and logs that have been stored may become immune on account of the reduction of the starch content. Eggs are generally laid in the pores of the wood, and only timbers with large enough vessels to allow the introduction of the beetles' ovipositor are susceptible. For this reason softwoods are immune. Exit holes are about 1/16th in. in diameter. The dust in the tunnels is a flour-like powder. Avoidance of sapwood will prevent attack. Affected timber may be kilned, which will effectively kill beetles or larvæ. Preservatives may also be used.

DEATH WATCH BEETLE (*Xestobium rufovillosum*). Usually old hardwoods of fairly large dimensions, *e.g.*, beams, etc., in old churches, are attacked. The beetles emerge between April and June and lay their eggs in cracks, etc., or in old exit holes. The larvæ bore from 18 months to several years, according to conditions. Exit holes are about $\frac{1}{8}$ in. across, and the galleries are filled with a coarse dust containing small bun-shaped pellets.

Timber should be kept dry, as a high moisture content induces fungal attack, which, even if not serious in itself, renders the wood prone to attack by Death Watch beetle. Where damage has taken place, the affected timber should be removed and the rest treated with creosote or some other preservative; this should be done annually for several years.

LONGHORN BEETLES (of the family *Cerambycidae*). These attack living trees—generally such as are unhealthy, and continue to work in the timber after felling. Usually the sapwood only is attacked, but the heartwood is sometimes affected. Large tunnels, $\frac{1}{8}$ to 1 in. in diameter, are bored; they are characteristically oval in section and packed with coarse dust. Although fairly common, the insect is rarely important. Control is by rapid extraction, and removal of bark, especially in susceptible species (*e.g.*, poplar, willow and larch). Kilning will also destroy the pest.

PINHOLE BORERS (belonging to the families *Scolytidae* and *Platypodidae*). The beetles (not larvæ) tunnel in the wood of living trees and freshly felled logs, mainly hardwoods. The galleries are narrow, 1/50th to $\frac{1}{8}$ in. in diameter, across the grain—through sapwood and heartwood; they are usually free from dust and often darkly stained. Control is by rapid conversion and seasoning. The beetles are rare in home-grown timbers.

WOOD WASPS (*Sirex* spp.). These attack softwoods, both sapwood and heartwood, either whilst the tree is standing or logs soon after felling. As the larvæ may bore in the wood for several years, even after conversion and seasoning, the adult insect sometimes emerges after the timber is in use, for example in new houses. The galleries are large, but may be distinguished from those of longhorn beetles by being round in section.

GENERAL CONTROL MEASURES. In the case of beetles it is desirable to kill the adults before they emerge from the timber and lay their eggs. Preservatives should be applied during early summer and for several years in succession. Creosote, benzine and turpentine may be used; there are also a number of effective proprietary compounds.

PRESERVATION

It has been pointed out that one of the essentials of life for fungi is a food supply; this is also true, of course, of insects. The object of preservation is to poison that food. The cellular nature of timber renders the treatment by preservative liquids easier, especially as most of the cells are connected by pits (see under 'Structure'). The fact that sapwood is more permeable than heartwood is partly due to anatomical changes, as well as to chemical and physical alterations.

There are three main types of preservatives:

1. *Oily Types.* By far the most important is creosote, which may be used for all outdoor purposes, and some interior work. It is not ideal for the latter, as it discolours the wood, cannot easily be painted, and tends to 'bleed' through plaster, etc.

2. *Water-soluble Types.* Not so good as creosote out of doors, as they tend to wash out; better in buildings, being mostly colourless and can be painted. They include solutions of such chemicals as sodium fluoride, zinc chloride, mercuric chloride, etc.

3. *Solvent Types.* A poison is dissolved in a solvent, such as naphtha, spirit or volatile oil. By this means a better penetration is obtained by non-pressure methods than with other types; generally, however, they are more expensive.

METHODS OF APPLICATION. The efficiency of any preservative largely depends on its method of application. Brush treatment is almost useless with croesote, but may be sufficient (if thoroughly done) with solvent types. Spraying is better, but still of little value with creosote. Dipping is one stage better, and with solvents is quite satisfactory. The 'open tank' method is good for fairly permeable timbers; here the timber is heated in a bath of preservative until a temperature of 160–200° F. is reached; this is maintained for 2–4 hours, and then the liquid is allowed to cool. Penetration takes place during cooling. The most thorough method of all is by using pressure; the timber is totally enclosed in a metal cylinder, and the preservative forced in under high pressure.

The permeability of timber varies from extremely resistant, *e.g.*, European oak heartwood, to absorbent or permeable, *e.g.*, beech or Scots pine sapwood. Some resistant timbers, especially Douglas fir, are often *incised* before treatment. A special machine makes a regular series of incisions in the timber, sufficiently close together so that the lateral spread of preservative from each cut will cover the timber uniformly to the depth required.

SEASONING

The importance of seasoning can hardly be overestimated. Unseasoned timber is more prone to decay, is weaker in most strength categories, and is apt to warp and split—amongst other disadvantages. The urgent demand for quick supplies of home-grown timber during the war has resulted in a considerable amount of trouble, owing to the lack of time for proper seasoning.

Green timber has a certain quantity of free moisture in the cell cavities. When this is all dispersed the 'fibre saturation point' is reached. Further drying results in moisture being drawn from the cell walls, and it is this which constitutes true seasoning. It should be realised that the terms 'seasoning' and 'drying' are synonymous.

When moisture is drawn from the cell walls, the timber begins to shrink. Shrinkage is greatest in the direction of the growth rings, *i.e.*, tangentially to the circumference of the trunk; radial shrinkage is only about half the amount. For this reason floorboards, etc., should be cut radially (known in the trade as 'quarter sawn') when possible. Unequal shrinkage is the cause of splits, shakes, checks and warping. End splitting of logs and boards during drying is due to the greater loss of moisture from the end grain. This may be largely prevented by covering the ends, either with metal 'cleats' nailed at either end, or a waterproof paint. There are a number of such paints; the U.S. Forest Products Laboratory recommend the formula: 25 parts asbestine and 25 parts barytes to 100 parts hardened gloss oil (the oil itself should be of a thick grade and made up of about 8 parts quicklime, 100 parts rosin and 57·5 parts naphtha). Desch (117) recommends: 1 part finely powdered, unburnt brick clay and 1 part ground dammar mixed with sufficient paraffin to permit spreading. Several proprietary bituminous paints are also effective.

The degree of dryness of a piece of timber is expressed as its *moisture content*, which is simply the weight of moisture in the timber expressed as a percentage of its dry weight. It may be obtained by the formula:

$$\frac{\textit{Initial weight of sample} - \textit{Dry weight of sample}}{\textit{Dry Weight}} \times 100.$$

The dry weight is found by drying the sample in an oven until, after repeated weighings, no further loss of weight occurs.

There are now electrical moisture-content meters which work on the principle that the greater the amount of moisture present in the timber, the higher its electrical conductivity. The advantage of such meters is that they give instantaneous results, oven drying, etc., being obviated.

The moisture content of timber should correspond to the humidity of its surroundings when in use, and this is being increasingly realised by users of timber.

There are two main methods of seasoning: air seasoning and kilning. In some cases a combination of the two methods is used: oak, for example, is usually air dried for several years and finished in a kiln. In this country the moisture content of timber dried in the open is seldom below 18%, except in very warm, dry weather, whereas it is necessary in modern centrally heated buildings for this figure to be 10–12%, or even less. It is obvious, therefore, that kilning is necessary.

AIR SEASONING. In this method the sawn timber is stacked in piles well clear of the ground, and each layer of boards separated from the next by 'stickers' (rectangular pieces of wood, usually spruce, $\frac{3}{4}$ to 1 in. square, long enough to stretch the width of the pile, or stack). Piling timber in this way is known as 'putting it in

stick', and the object is to allow air to circulate freely round each piece of timber. The stack usually has a sloping roof to carry off the rain.

It is difficult to regulate the speed of drying, but one method is by varying the thickness of the stickers (the thinner they are the slower the drying). Also easy drying softwoods should be stacked in late spring or early summer so that they dry quickly and thereby prevent undue staining; they will stand this treatment without damage and need not be stacked so long. Hardwoods and the more refractory softwoods should be stacked in winter so that the high humidity prevents too quick initial drying.

KILNING. The timber is sticked in the same way as with air seasoning, but placed in a kiln. This method has the great advantage that humidity, heat and air circulation may be regulated at will. In the early stages of seasoning the humidity is kept high by the free introduction of steam and the heat (from heating coils) kept low; as drying progresses the humidity is lowered and the temperature raised until the required moisture-content is obtained. Timber often behaves differently in kilning from air-seasoning and notes on the differences are given in the descriptions of species.

CHEMICAL SEASONING. A modern method of seasoning is to treat the surface of the timber with a salt (urea has been found one of the most satisfactory chemicals) either by dipping in a solution of the salt or by spreading dry crystals over the surface and allowing the moisture in the timber to dissolve them. The presence of the chemical in the outer layers of the wood keeps this area moist whilst the inner layers are drying; at the same time it encourages the movement of the moisture from the inner portion to the surface. The theory of this action is that the vapour pressure in the wood is lowered by the chemical, and so water vapour is drawn out of the inner portion—in spite of the fact that the surface is still moist.

STRENGTH PROPERTIES

The term strength should be qualified so as to indicate what kind of strength is meant, for example, strength in compression or bending. This is important in order to determine whether a timber has suitable strength properties for a particular purpose. Thus oak is very stiff, but has not great elasticity, and so is suitable for a beam, but not for an axe helve; with ash exactly the reverse is true.

Generally speaking, all strength properties increase with density, but often specific properties differ in species of the same density.

The strength of any particular timber is affected by a number of factors, including the locality in which the tree was grown, the manner in which the piece was cut from the log, and the position in the tree yielding the timber. Defects are one of the most important factors, and species commonly having many knots, or with spiral grain, frequent splits or other defects may, in practice, have less strength than other timbers, having lower figures in tests on clear specimens. Moisture content has already been shown to have a marked effect on strength, green timber being decidedly less strong in most categories than seasoned timber. It should be mentioned, however, that there is no increase until drying has passed fibre saturation point; further drying results in rapid increases, up to 100% in some categories.

The rate of growth of the wood is a factor in certain classes of timber; softwoods usually have an optimum rate of growth for maximum strength, and in America certain softwoods are often specified with a limited range of growth rings per radial inch for structural purposes. Ring-porous hardwoods (see page 22) are also influenced by rate of growth, generally speaking the faster the growth the stronger the timber. On the other hand, there is no relation between strength and rate of growth in diffuse-porous woods. Considerably modifying the foregoing factor is the variation in the structure of timber; for instance, a high proportion of spring wood in the growth rings will tend to reduce strength, also the proportion of fibres to parenchyma is important (the greater the quantity of fibres the stronger the timber).

In practice, timber, when in use, is often subjected to several strains at the same time, but usually one predominates. This last fact is the reason that it is necessary to know the comparative strength values of any timber, and also how any one value varies in different timbers.

There are a more-or-less standardised number of tests to which timber is put in order to arrive at a complete picture of its strength. The properties investigated are:

BENDING STRENGTH. The 'modulus of rupture' or maximum bending strength of a timber is used in gauging the sizes necessary for joists, rafters, chair legs, and in fact for most purposes.

STIFFNESS (or modulus of elasticity). Often more important than the maximum bending strength, since it is essential that joists, etc., should not bend to any extent under load. It is also the limiting factor in the strength of long posts or struts of small sectional area.

SHOCK RESISTANCE, or strength in impact

bending, often called toughness. Is important in timbers used for such purposes as sports goods, axe, pick and other shafts, etc.

COMPRESSIVE STRENGTH. Is the resistance to crushing as in pit-props, columns, etc., of fairly large sectional area. The suitability of timber for airscrews is based on this strength property.

SHEARING STRENGTH. Or the resistance to a force tending to slide one part of the timber over the remainder. It is important in tenoned and other joints, etc.

TENSILE STRENGTH. Parallel to the grain is comparatively unimportant, as the timber would fail from other strains first. Tension perpendicular to the grain is of greater importance, but even this is seldom called into play.

HARDNESS. Is of obvious importance and gives some idea of the relative ease of working of a timber.

RESISTANCE TO CLEAVAGE. The ease with which wood splits determines its value for nailing for instance. Green wood splits more easily than after seasoning.

TOUGHNESS. Usually implies the capacity of wood to resist impact-bending stresses, but it may be used to describe a wood that can be bent to a considerable degree, without breaking, is difficult to pull apart or is difficult to split.

WORKABILITY

Generally speaking timber works to a better finish when seasoned than when green. For this reason descriptions of workability refer to seasoned material. An exception is in the case of conversion from the log, which, in home-grown timber, is usually cut more or less green.

Breaking down of the log into boards, planks, etc., is carried out by a rip saw, which may be a circular, band or frame saw (the latter is not often used for home-grown timber). This process is usually known as ' ripping '.

There are two types of saw teeth : (1) *Spring set*, *i.e.*, when each tooth is bent at a slight angle to the face of the saw, adjacent teeth being bent in opposite directions ; (2) *Swage set*, *i.e.*, where the point of each tooth is pressed out so that it extends slightly beyond each face of the saw. Spring-set teeth are always used for cross-cutting ; swage-set are preferred for ripping, especially for band saws, as greater speed can be obtained.

The most important operation, next to sawing, is planing. This is done commercially on a mechanical planer, which works on a different principle from the hand plane. Two or four knives are fixed to a block, which is the width of the planer. This block is rotated at high speed, the edges of knives projecting slightly through a gap in a steel table. The action on the wood surface is that numerous shallow, curved cuts are made across the wood in the direction of the grain.

The *cutting angle* is important in planing. This is defined as the angle between the face of the knife and the normal of the wood. A large angle is suitable for straight-grained timbers, but a small angle is necessary where interlocked or other irregular grain is present, to avoid the grain ' picking up ' (*i.e.*, bundles of fibres being torn from the surface). The Forest Products Research Laboratory suggest that the cutting angle may be reduced by honing or grinding a narrow bevel on the leading face of the cutters.

CHAPTER III

THE STRUCTURE OF TIMBER

By far the most certain way of identifying timbers is by an examination of their structure with the aid of a microscope, in fact it is the only way to divide out some species with any degree of certainty. Skilled workmen who have handled timber all their lives can usually identify timbers by their general appearance, colour, feel, smell, etc., but this is not an infallible method, and in any event takes a lifetime to acquire. In the present work, therefore, the structure of timbers is described by means of notes and semi-diagrammatic drawings ; these should be used in conjunction with the general description of the wood and the photographs (which are actual size of grain). The structure, however, has the last word ; if this does not fit in with your identification—then your identification is wrong, no matter what other characteristics agree.

CELLULAR STRUCTURE

All plants are composed of cells, elements of varying shapes, but always consisting of a definite wall enclosing a space, which may be empty or contain liquids—and occasionally solids, *e.g.*, crystals. The cells of wood are cemented together to form a strong, solid mass—

timber. The types and distribution of the cells largely determine the quality and behaviour of the particular species of timber. Thus timbers having a preponderance of cells with thick walls and small cell-cavities are hard and difficult to work, and *vice versa*.

HOW A TREE GROWS

New tissues are formed by specialised cells

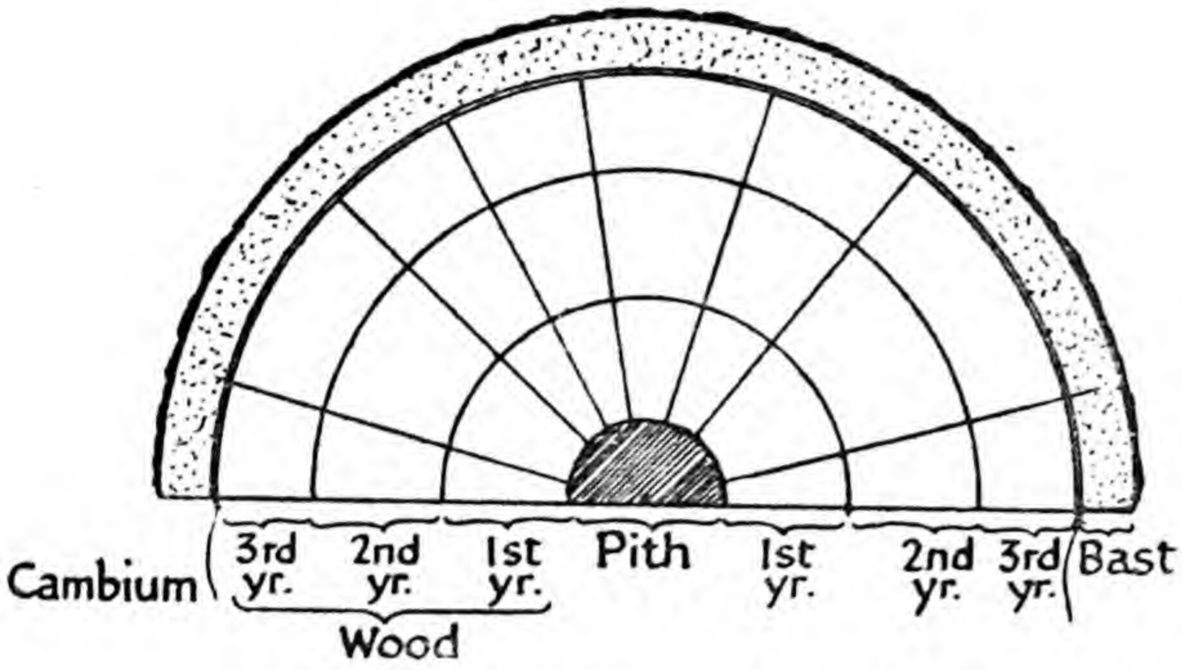

Fig. 1. *Cross-section of a* 3*-year stem* (diagrammatic).

dividing into two, the one half enlarging, and other again dividing; this process is repeated constantly during growth. Growth necessitates a supply of food; this is obtained in the following manner; first the roots absorb water (and dissolved mineral salts) from the earth which are conducted up the trunk, in the sapwood to the leaves. The leaves take in carbon dioxide from the air and, with the water from the roots, manufacture starches and sugars with the aid of sunlight acting on the chlorophyll in their cells (a process called ' photosynthesis '). The food thus formed is transmitted down the trunk and to all branches and twigs through a thin layer of cells called the *phloem* (or *bast*) which is situated immediately under the bark. Directly under the phloem is an even thinner layer of cells known as the *cambium*. This tissue is where growth originates; the thin-walled, living cells of which it is composed, divide by forming walls parallel to the axis of the stem. Cells cut off furthest from the bark enlarge considerably and the walls become thickened; in the mass these cells form the wood. Cells nearest to the bark ultimately become the phloem, the amount of which is so small, compared with the wood, that it is indistinguishable by the naked eye.

The cambium extends over the whole tree—trunk, branches and twigs, and with every division of its cells it adds, as it were, an overcoat of wood to the tree. The growth rings can be regarded as the overcoats added annually.

When first formed the wood cells are thin-walled, all similar in shape, and contain living protoplasm. They quickly become modified in shape and texture; the walls become thickened and hardened by the depositing on the original cell walls of a substance called *lignin;* the protoplasm dies in most of the cells when lignification is complete, and this inhibits all further growth. The thickening of cell walls is not always even, sometimes it is in ridges or in the form of spirals.

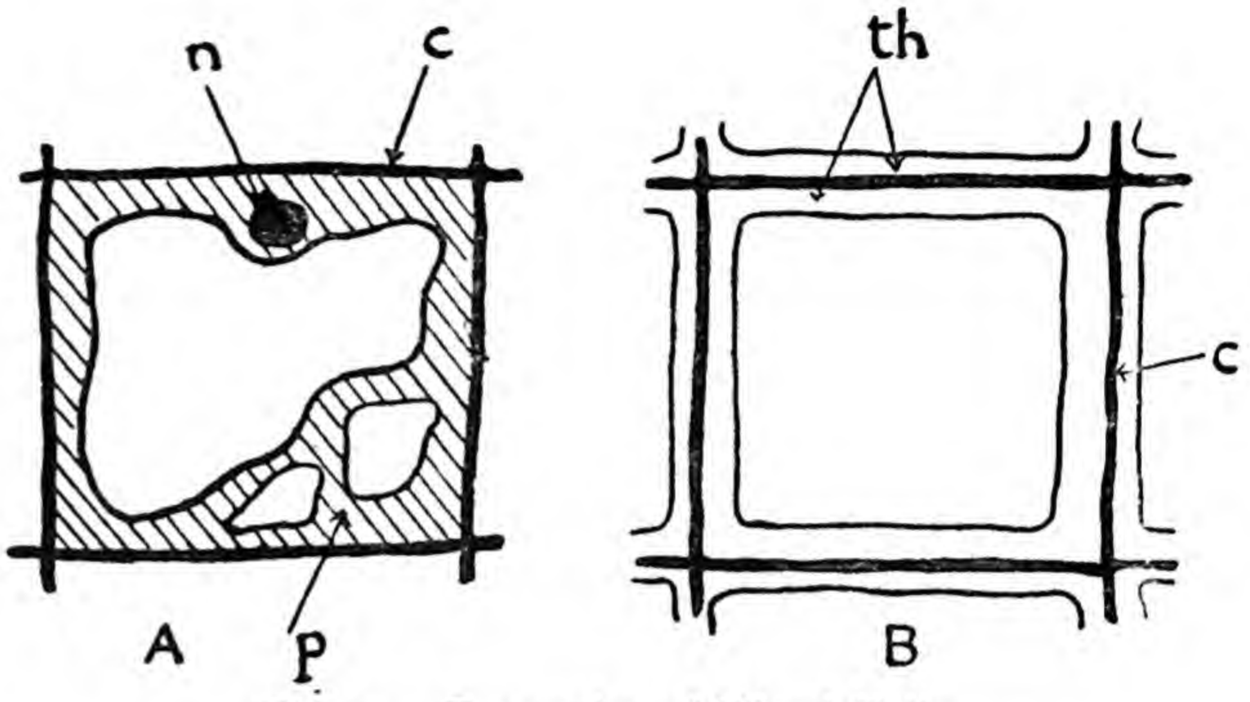

Fig. 2. *Formation of Wood Cell.*

A. Young cell with living contents. 'c' unthickened cellulose wall. 'n' nucleus. 'p' cytoplasm.

B. Old cell with thickened walls and no living contents. 'th' thickening. 'c' now called the middle lamella.

TIMBER ANATOMY

The type of cell varies according to its function. There are three main duties of wood cells in the tree: (1) conducting sap from roots to leaves, (2) forming a strong trunk or branch to withstand wind pressure, (3) storage of foodstuffs.

The anatomy of timber can be studied by

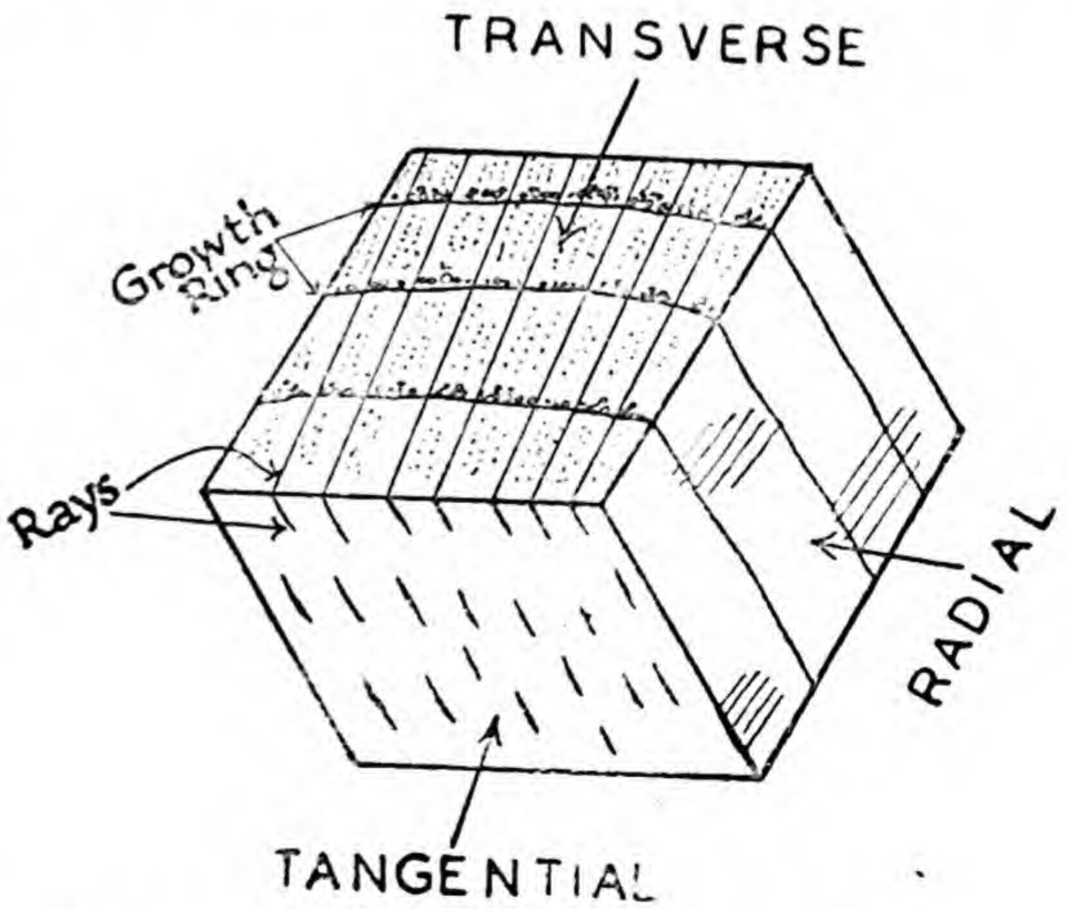

Fig. 3. *Planes for the Sectioning of Timber.*

examining thin sections of the timber under a microscope. These sections should be cut in

three directions to give the complete picture, *i.e.*, transversely, radially and tangentially (see fig. 3).

The structures of the two big groups of commercial timbers, *i.e.*, softwoods and hardwoods, are quite distinct. It is convenient, therefore, to deal with these two groups separately.

SOFTWOODS. Conifers are more primitive plants than dicotyledons, and for this reason the structure of their wood is simpler. There are, in fact, only two distinct types of cells in softwoods : *tracheids* and *parenchyma*. *Tracheids* are elongated cells, usually rectangular in cross-section and with rounded or bluntly pointed

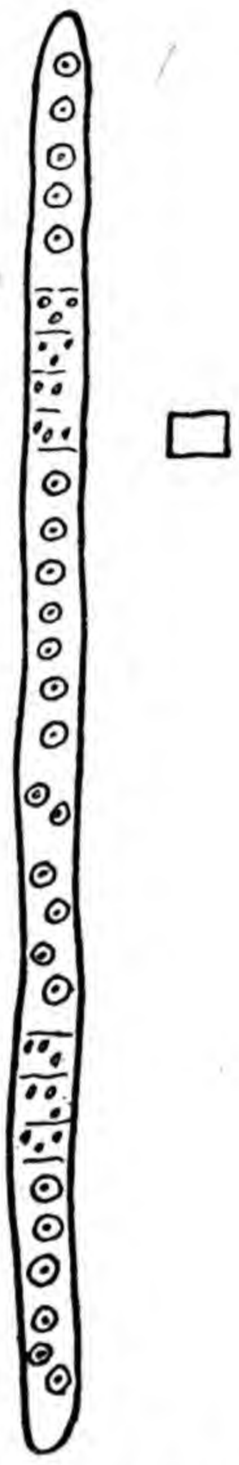

Fig. 4. *Tracheid of a Conifer.*

ends (see fig. 4), fully lignified and without living contents when mature. They are arranged in radial rows and the walls contain *pits* through which liquids may pass from one cell to another; in this way the sap rises from the roots to the leaves. Tracheids formed in spring have comparatively thin walls and large cell cavities ; with those formed later in the year the reverse is the case, and they are also often compressed radially. This change in the tracheids may take place suddenly, *e.g.*, in Douglas Fir, or gradually, *e.g.*, spruce or silver fir (see plates 28 and 21). It is also responsible for the very marked growth rings which characterise softwoods.

Pits. These are basically small areas of the cell wall which have remained unthickened and so allow the passage of liquids from one cell to another. The original cell wall is left (and now called the *middle lamella*), but this is permeable to liquids. The type, arrangement and number of pits is of considerable importance in identification. There are two main types of pits :

1. *Simple Pits.* Small areas of unthickened wall, which may be round, slit-like, square or angular. Usually, there is a corresponding pit in the neighbouring cell wall (see fig. 5, A and B).

2. *Bordered Pits.* The area of unthickened wall is fairly large and usually circular, but over it the thickening forms a dome with a small hole at the centre (see fig. 5, C, D and E). The middle lamella opposite the hole or opening is locally thickened into the *torus :* under certain conditions the torus can block up the pit by covering

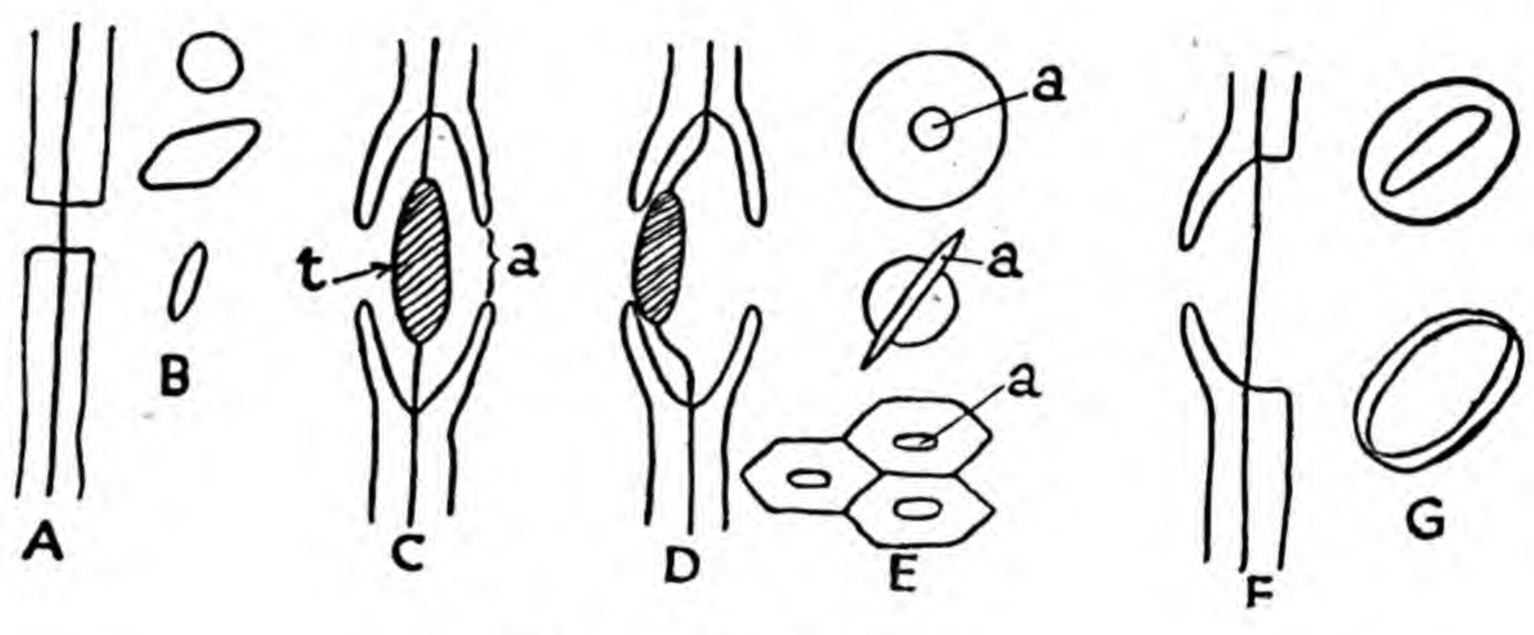

Fig. 5. *Types of Pits.*

A. Simple pit. B. Frontal aspects of different types of simple pits. C. Bordered pit. D. Bordered pit with torus closing one aperture. E. Frontal aspects of various types of bordered pits. F. Semi-bordered pits. G. Frontal view of two common types of semi-bordered pits. *a.* aperture. *t.* torus.

one of the openings. In frontal view a bordered pit usually appears as two concentric circles, but modifications are common, as shown in fig. 5, E.

There are various modifications of these two types, *e.g.*, semi-bordered pits (see fig. 5, F and G) in which one-half of the pit is bordered and the other simple, etc.

Ray Tracheids. Cells similar to tracheids in shape and having bordered pits, but at right angles to the vertical tracheids and usually found at the edge and sometimes in the middle of rays.

Parenchyma. Thin-walled cells, more or less brick-shaped, often containing protoplasm when in the sapwood. Their function is food storage and the pits between them are simple or semi-bordered.

Rays. Most of the parenchyma cells are grouped into thin plates running across the grain in a radial direction. Usually these rays are only

one cell wide (uniseriate) but may be two or even three (see fig. 6).

Resin Canals. The secretion of resin is characteristic of many softwoods; when in quantity this is usually carried out by resin canals, which run in two directions: parallel to and at right angles to the grain. Around the canals are thin-walled epithelial cells which secrete the resin and pour it into the canal cavities.

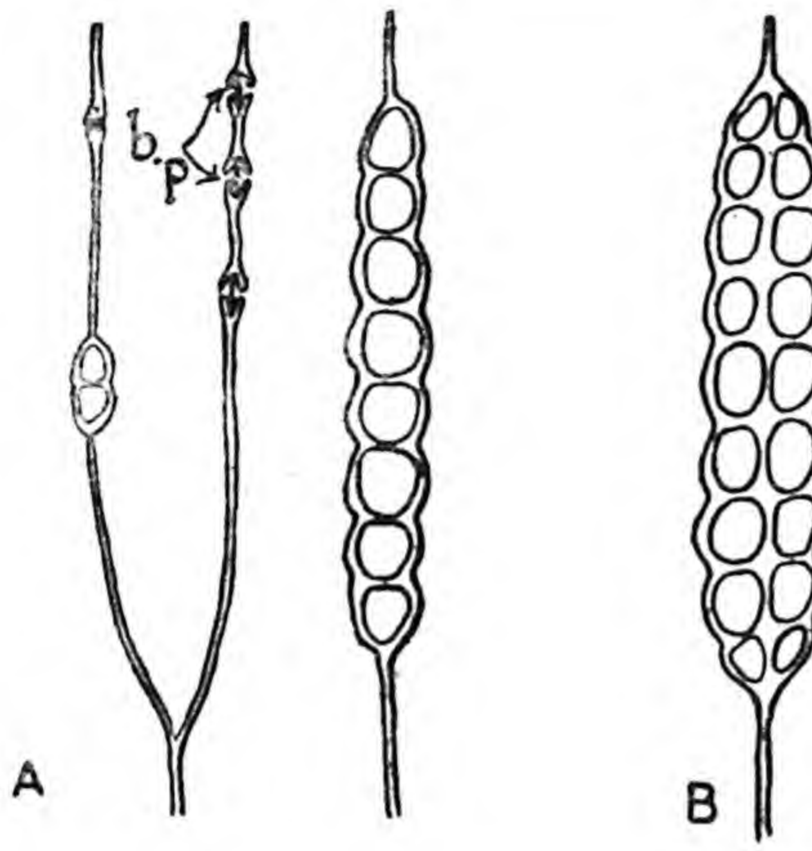

Fig. 6. Rays in Softwoods.

A. Tangential section through rays and tracheid walls, showing uniseriate rays. 'b.p.' bordered pits.
B. Ray two cells wide.
C. Radial section through ray. 'p' pits between ray cells and tracheids. 'r' ray-crossing. 'rt' ray tracheid. 't' tracheid.

Resin cells. Some genera of softwoods are only slightly resinous, and these are not furnished with resin canals but have a number of modified parenchyma cells which store resin: they are known as 'resin cells'.

HARDWOODS. The anatomy of hardwoods is more complex than that of softwoods, as there is more specialisation of cells for different functions. This actually facilitates identification, as there are greater and more obvious differences between genera and species than in softwoods.

Vessels or Pores (or Tracheae). These cells carry out the conduction of sap from the roots to the leaves. They are more or less cylindrical and placed one over the other to form a continuous tube (often many feet long). The end walls are either missing or perforated, to allow the free passage of liquids. Perforations are usually in the form of slits, and the term

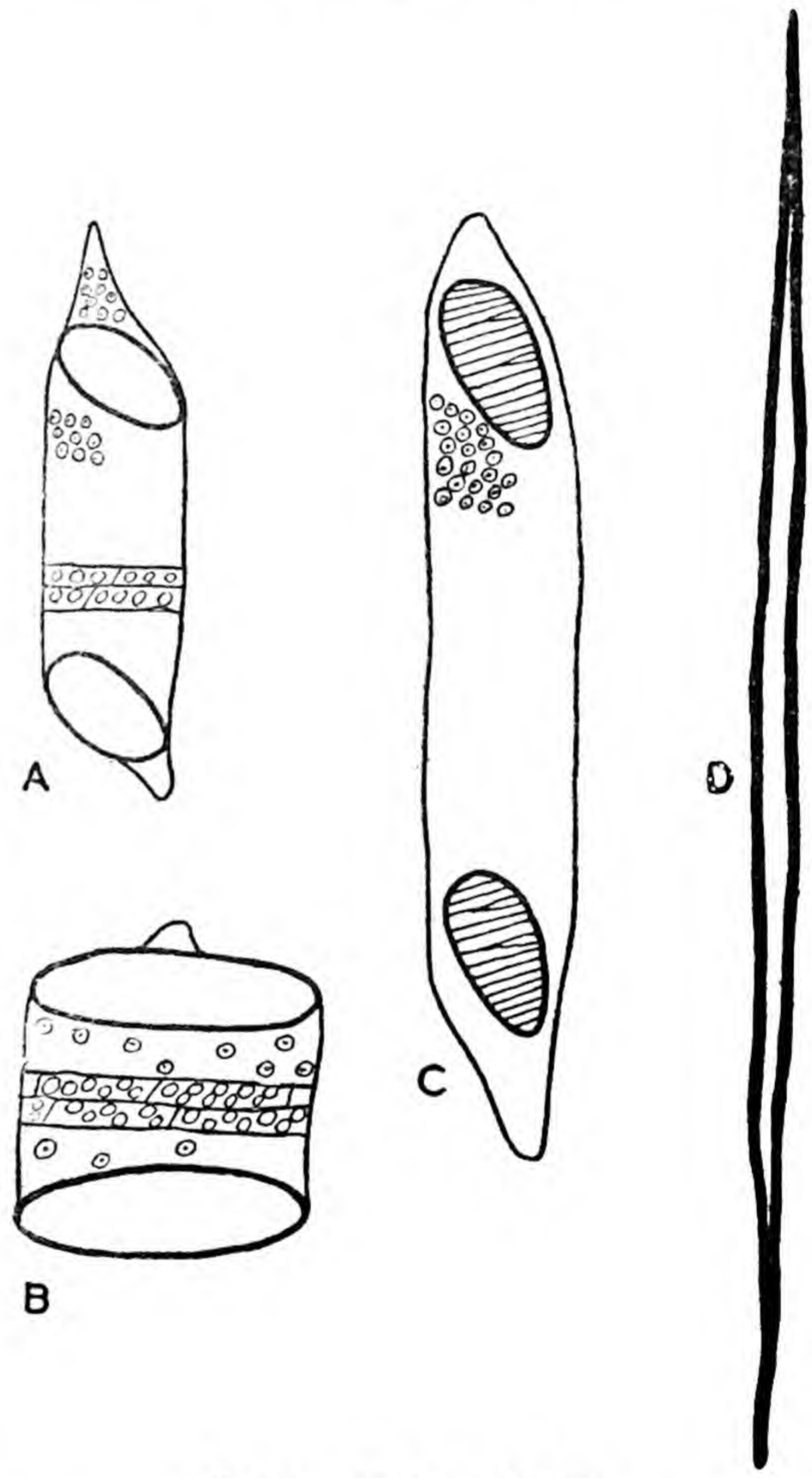

Fig. 7. Hardwood Cells.

A. Vessel with simple perforation. B. Short, wide vessel typical of oak. C. Vessel with scalariform bars. D. Fibre.

'*scalariform perforations*' is used to describe the end walls in such cases (see fig. 7, C).

The other walls of the vessels are frequently heavily pitted; when two vessels are continuous there are often numerous bordered pits between adjacent walls to allow the free passage of liquids laterally. When parenchyma cells touch vessels the pitting between them is generally simple.

Various forms of thickening are found in vessels : spiral or annular thickening is the most common.

Their diameter varies according to the time of the year they are formed, the species of tree, their position in the trunk, etc. They may be in groups or solitary.

When the vessels are no longer required to conduct water, *i.e.*, in the heartwood, they frequently become blocked by thin-walled but woody cells which grow out from the walls of the vessels and fill the cavities. These are known as *tyloses* and have the appearance of bubbles filling the vessels (see figs. 8 and 15).

Fibres. Corresponding to the tracheids of softwoods are the fibres of hardwoods. There is an important difference, however, between the two, because fibres mostly act only as mechanical support, whereas tracheids also conduct sap.

In appearance fibres closely resemble tracheids, but are sharply pointed, shorter and are less often pitted. Their arrangement is irregular and the thickness of the walls varies with the cells' position, but there is not the same definite gradation from spring to summer growth which characterises the tracheids in conifers. Like tracheids, the fibres form the groundwork of the wood except in rare instances where there is a preponderance of vessels and parenchyma. In some timbers the majority of fibres are very thick-walled, *e.g.*, Box, while in others they are fairly thin, *e.g.*, Willow. Occasionally, a type of fibre is found which retains its protoplasm and acts as a storage cell : this is called an ' intermediate fibre '.

Parenchyma. The parenchyma cells of hardwoods are so similar to those of softwoods that they become identical for practical purposes.

Rays. As in softwoods, the parenchyma forms rays, but these are extremely variable in size and composition. In Oak, for example, the rays may be 20 or more cells wide and more than 200 cells high. They can clearly be seen by the naked eye as the ' silver-grain ' or ' flower ' of Oak when it is cut on the quarter. In many other hardwoods the rays can be seen as lighter or darker-coloured flecks. Under the microscope the rays vary in shape considerably according to the species of timber ; some rays are boat- or barge-shaped on the tangential section, whilst others are shaped like a racing skiff ; others again are irregular in shape. The pits between adjacent ray cells or between vessels and ray cells are usually simple or semi-bordered, since there is no necessity for the contents of the cells to be moved quickly.

Paratracheal Parenchyma. Parenchyma cells are sometimes found surrounding the vessels, when they are given the name of ' paratracheal parenchyma '. The layer of cells may be one or many deep, according to the timber ; in some species the layers may become ' winged ' and form long bands either side of the vessel in a tangential direction ; often these bands meet and so connect one vessel with the next.

Metatracheal Parenchyma. This name is given to masses of parenchyma cells which form lines or groups that are not connected with the vessels.

Growth Rings. As previously mentioned, in temperate climates tree growth ceases during the winter months and there is usually a definite change in the structure of the wood at this hiatus in growth. The hardwoods can be divided into two groups according to their kind of growth in one year :

1. Ring-porous woods, and
2. Diffuse-porous woods.

In *ring-porous* hardwoods the vessels formed in spring are larger and form a more or less definite ring at the beginning of the annual growth. The vessels formed later in the year are very much smaller and the change in size is generally sudden. Examples of ring-porous woods are : Oak, Ash, Elm, etc.

Diffuse-porous woods do not show this sudden change in size of vessels, in fact there is frequently very little difference in size throughout the year's growth. Annual rings in these woods are more difficult to see (especially with the unaided eye) than in ring-porous woods. Examples are : Box, Horse Chestnut, Willow, etc.

Growth rings are also shown by the shape of the fibres, which are often flattened at the end of the season's growth, and also may have thicker walls.

METHODS OF PREPARING TIMBER FOR MICROSCOPIC EXAMINATION

The main object in preparing timbers for microscopic examination is to obtain as large and as thin a section of the wood as possible. By far the best method of achieving this is to use a ' microtome ' (of the heavy ' sledge ' type) ; this is an instrument which cuts large sections of any thickness mechanically. Unfortunately, such an instrument is too expensive to be available to most amateur wood anatomists ; however, a good heavy razor is quite satisfactory—the type with a thin, flexible blade should be avoided, as this easily gets chipped.

Preliminary Treatment of the Wood. Comparatively soft timbers can be cut without any more treatment than dipping in water or alcohol. (The surface to be cut should be kept wet to avoid the sections curling.) Hard timbers,

however, should be softened by boiling in water continuously until the timber sinks, after which they can be stored in a specimen tube containing a mixture of 50% glycerine and 50% industrial methylated spirits, until required for cutting. Extremely hard timbers should be softened even further by soaking for varying periods in commercial hydrofluoric acid. This should be carried out in a lead container, as the acid will affect glass and most metals. After soaking for periods ranging for 1–10 days (according to the hardness of the timber) the wood should be washed in running water for 24 hours, after which it can be cut with comparative ease.

Cutting. Three sections should always be cut of any timber, *i.e.*, in transverse, radial and tangential directions. Care should be taken that the cut is accurately made along these three planes, or difficulty will arise in the ultimate examination.

Staining and Mounting. When a good section from each of the three planes has been obtained they should first of all be stained. The easiest method is by the use of safranin which stains lignin bright red ; if a 1% aqueous solution of safranin is used the sections need only be placed in a drop for one or two minutes, after which they are washed in distilled water until all the surplus stain has been removed, then transferred to a watch-glass containing industrial methylated spirit for a minute, thence to fresh methylated spirit, and finally for a minute in absolute alcohol. After the last stage the sections are cleared in pure xylol. When the sections are placed in the xylol it should be noted whether any milkiness appears in the solution. If so, it means that the sections are not completely dehydrated, and if mounted in this state will show so many air bubbles that little can be seen of the structure of the wood. Should this happen the sections should be returned to the absolute alcohol for a further minute or so. After a minute in the xylol the sections may be mounted on a slide with Canada Balsam (in xylol). A line of balsam should be drawn along the side, the sections placed on this and the cover-slide, which should also have a line of balsam, is hinged on.

Careful pressure should be brought to bear on the cover slip in order to flatten the sections, and surplus balsam cleared from the edge.

If it is intended to use the slide for photomicrography the sections should be carefully flattened by the use of two wooden clothes-pegs placed close together, and allowed to remain in place until the balsam is set.

Finally the slide should be carefully labelled and allowed to dry.

Alternative Quick Methods. If a permanent slide is not necessary, sections may be mounted temporarily in glycerine (either pure or with 50% distilled water), which is better than water or alcohol as it shows up the minute structure (pits, etc.) more clearly. Glycerine jelly may also be used for semi-permanent slides.

Maceration. In order to examine the individual cells of a timber it is necessary to macerate a small piece (a splinter will be sufficiently large). This is carried out by placing the splinter in a test-tube containing a small amount of 50% nitric acid to which a few crystals of potassium chlorate have been added, the liquid should then be heated until the specimen turns white. The splinter is then removed, washed in distilled water and placed on a slide, where, with the aid of two mounted needles, the wood is teased apart. If the resulting mass is then placed in dilute glycerine or distilled water on another slide and a cover-slip placed over the whole, it will be found that the acid has dissolved the middle lamella of the cells and they are now completely separated and can be examined with ease.

CHAPTER IV

IDENTIFICATION OF TIMBERS COMMONLY GROWN IN BRITAIN

The diagrams on the following pages have been arranged for easy comparison, section by section, to facilitate rapid identification. Thus transverse sections of ring-porous hardwoods are placed first ; these are followed by diffuse-porous species, and here tangential or radial sections have been included as being necessary for identification. Softwoods are placed last and here transverse sections have been omitted as being of less diagnostic importance. Only those sections and structural features which are essential for the identification of these timbers have been included.

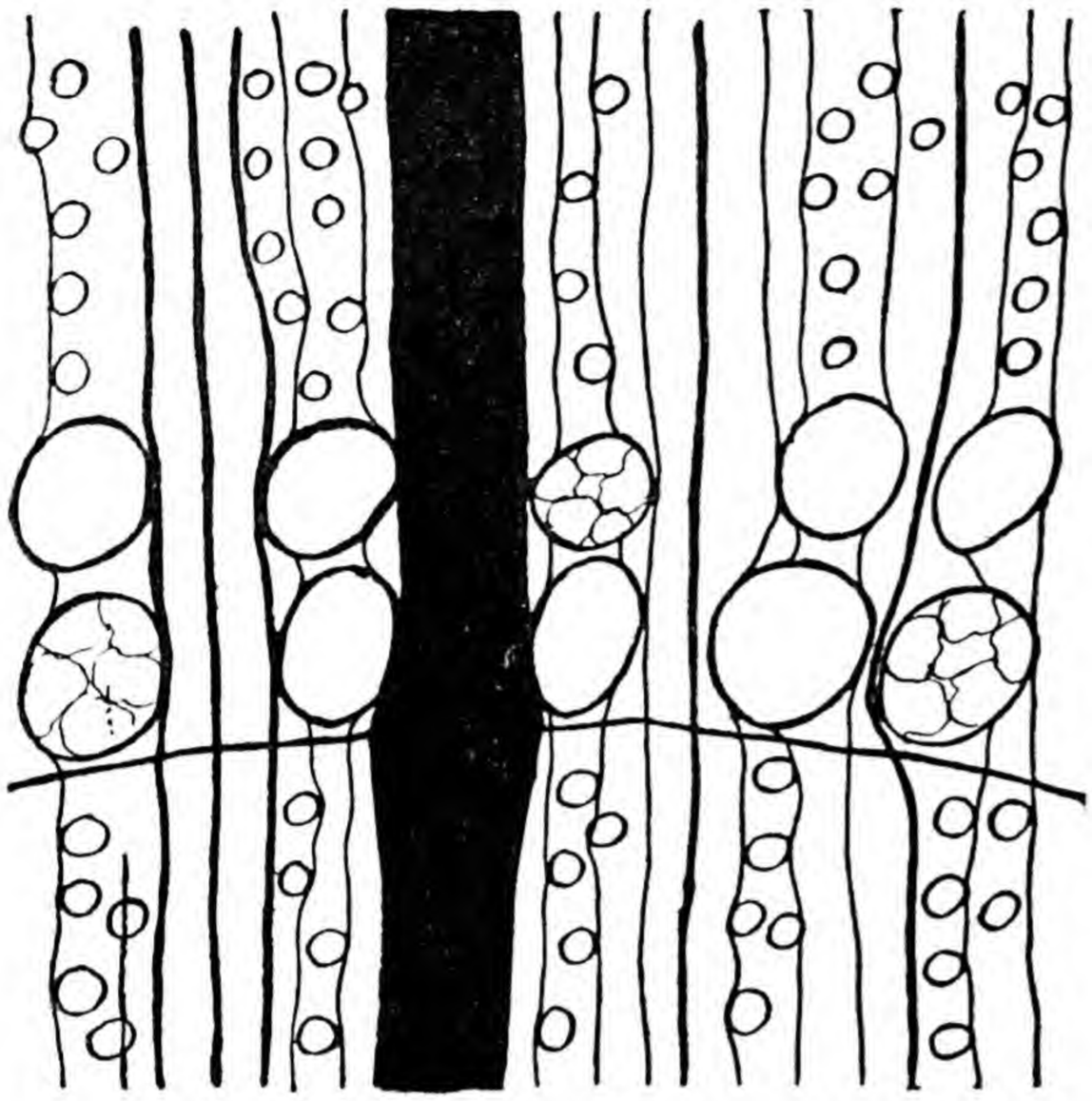

Fig. 8. COMMON OAK (*Quercus Robur*)

Transverse Section : Ring-porous wood.

Vessels large, averaging 1–4 rows deep. Tyloses present. Vessels in summer wood small and in radial arrangement.

Rays. Of two sizes :

(*a*) Broad rays—being the largest in home-grown timbers, slightly noded where they cross the end of the season's growth. (*b*) Fine rays.

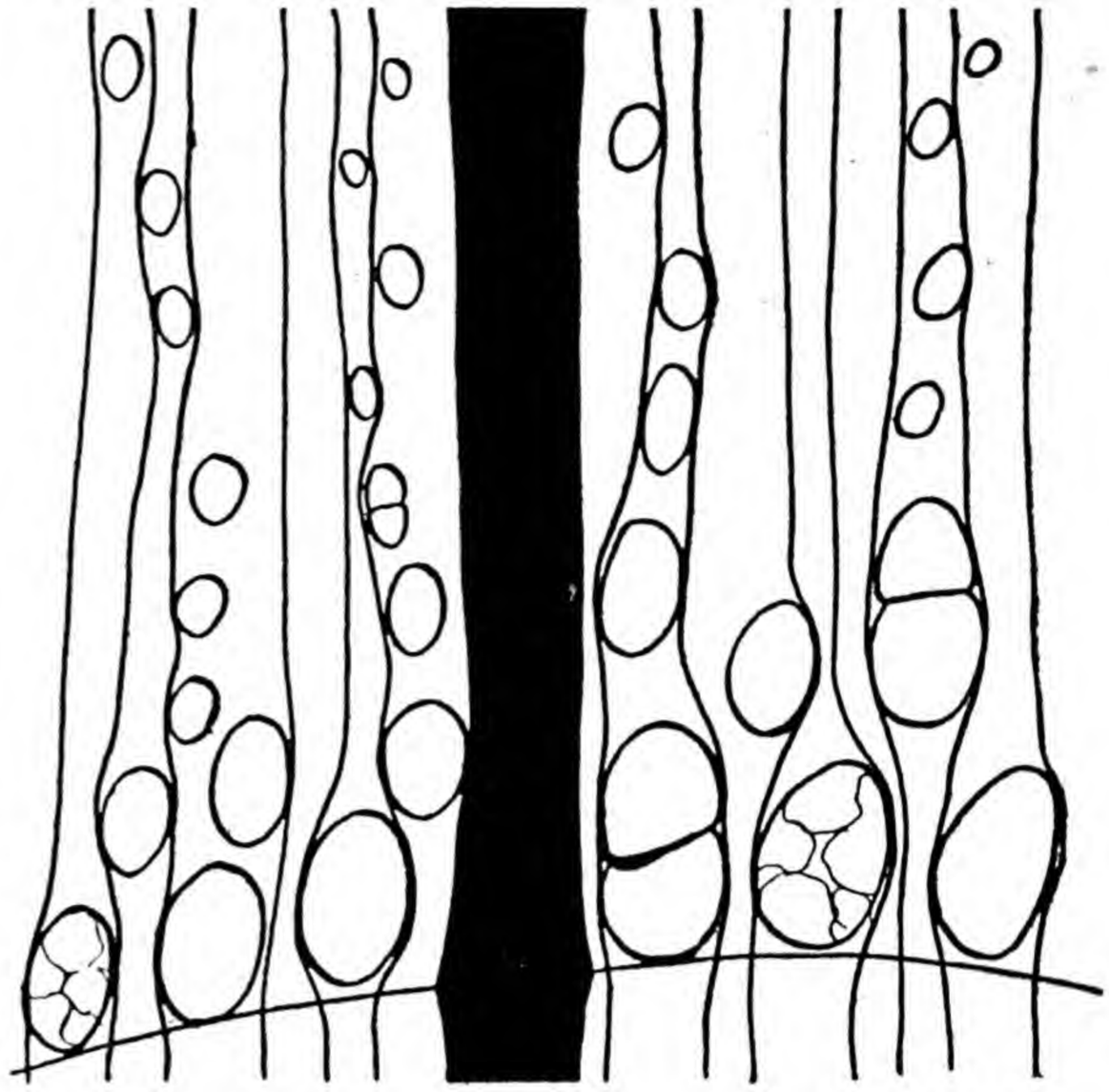

Fig. 9. TURKEY OAK (*Quercus Cerris*).

Transverse Section : Ring-porous wood.

Vessels somewhat oval, gradually diminishing in size from spring to summer wood—few, and isolated, in radial arrangement. Tyloses in vessels sometimes present.

Rays large, prominent, slightly noded where they cross the end of the season's growth. Small rays also present.

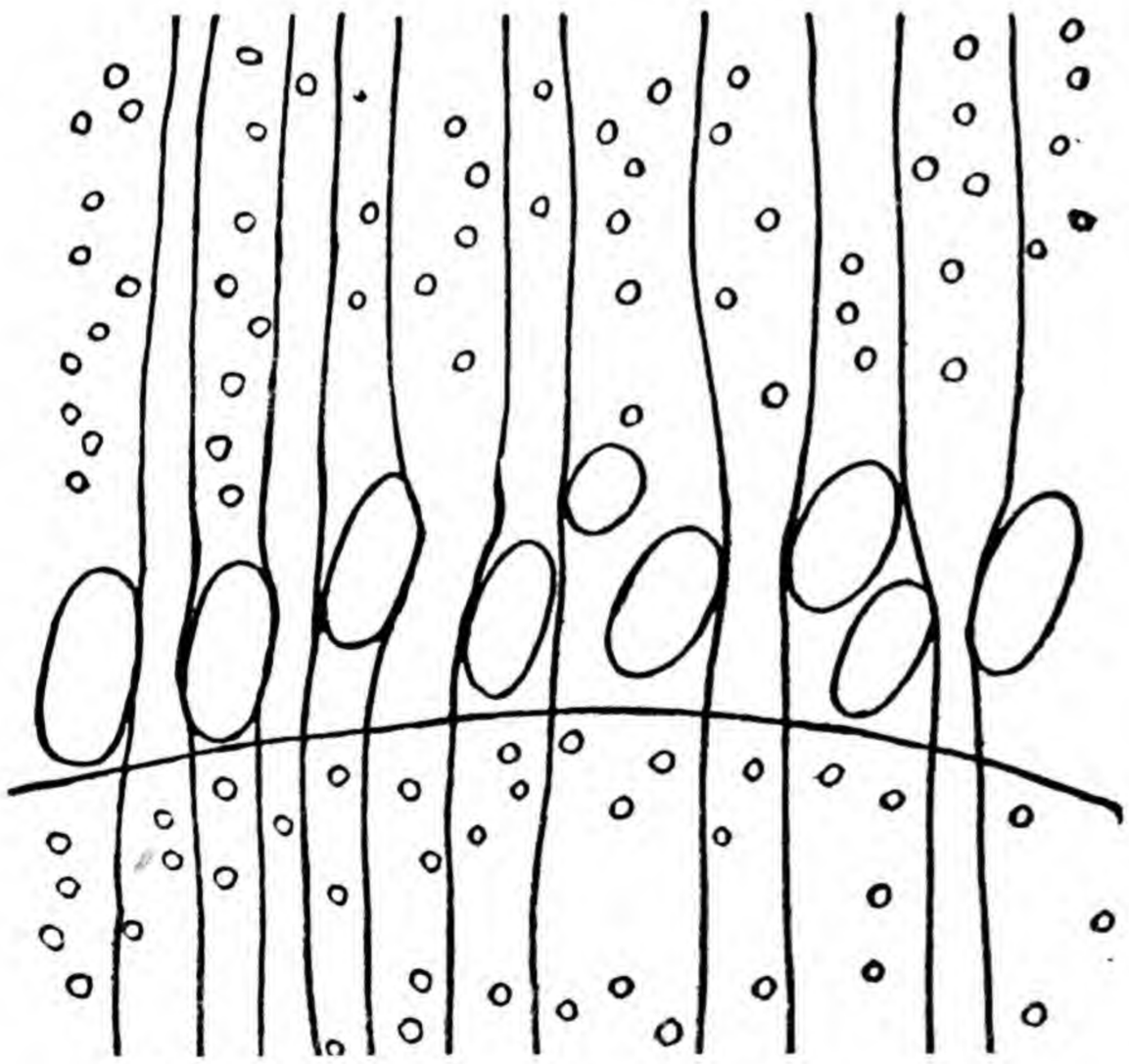

Fig. 10. SWEET CHESTNUT (*Castanea sativa*)

Transverse Section : Ring-porous wood.

Vessels distinctly oval and from one to several rows deep in the spring wood. Vessels in summer wood, mostly single and small, and in radial arrangement.

Rays. Very fine, undulating and abundant.

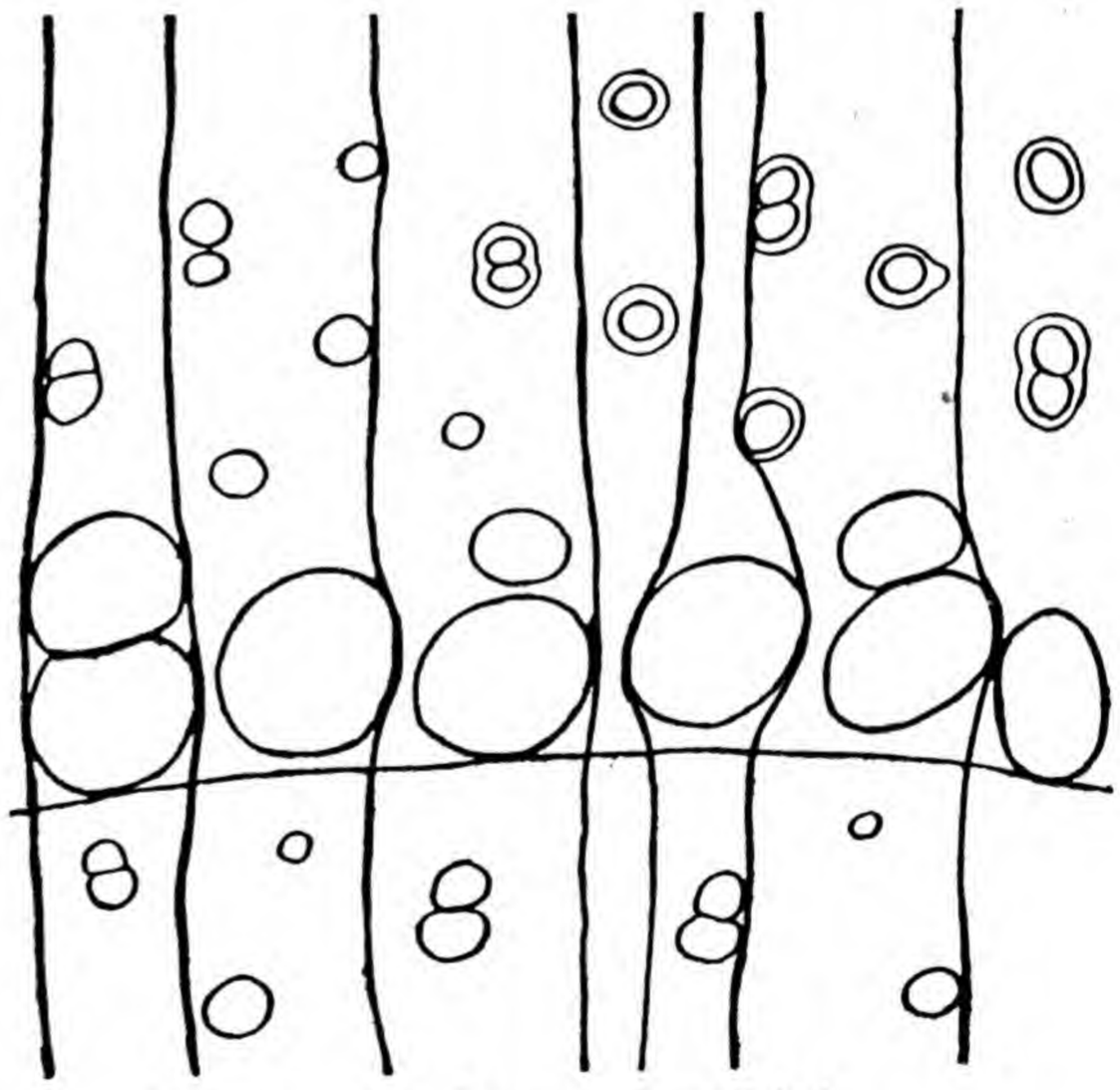

Fig. 11. ASH (*Fraxinus excelsior*).

Transverse Section : Ring-porous wood.

Vessels large in the spring growth, often arranged in pairs, and may be 2, 3, or more rows deep. Vessels in summer wood frequently arranged in twos and surrounded by parenchyma (which sometimes extends into slight lateral wings). *Rays.* Fine.

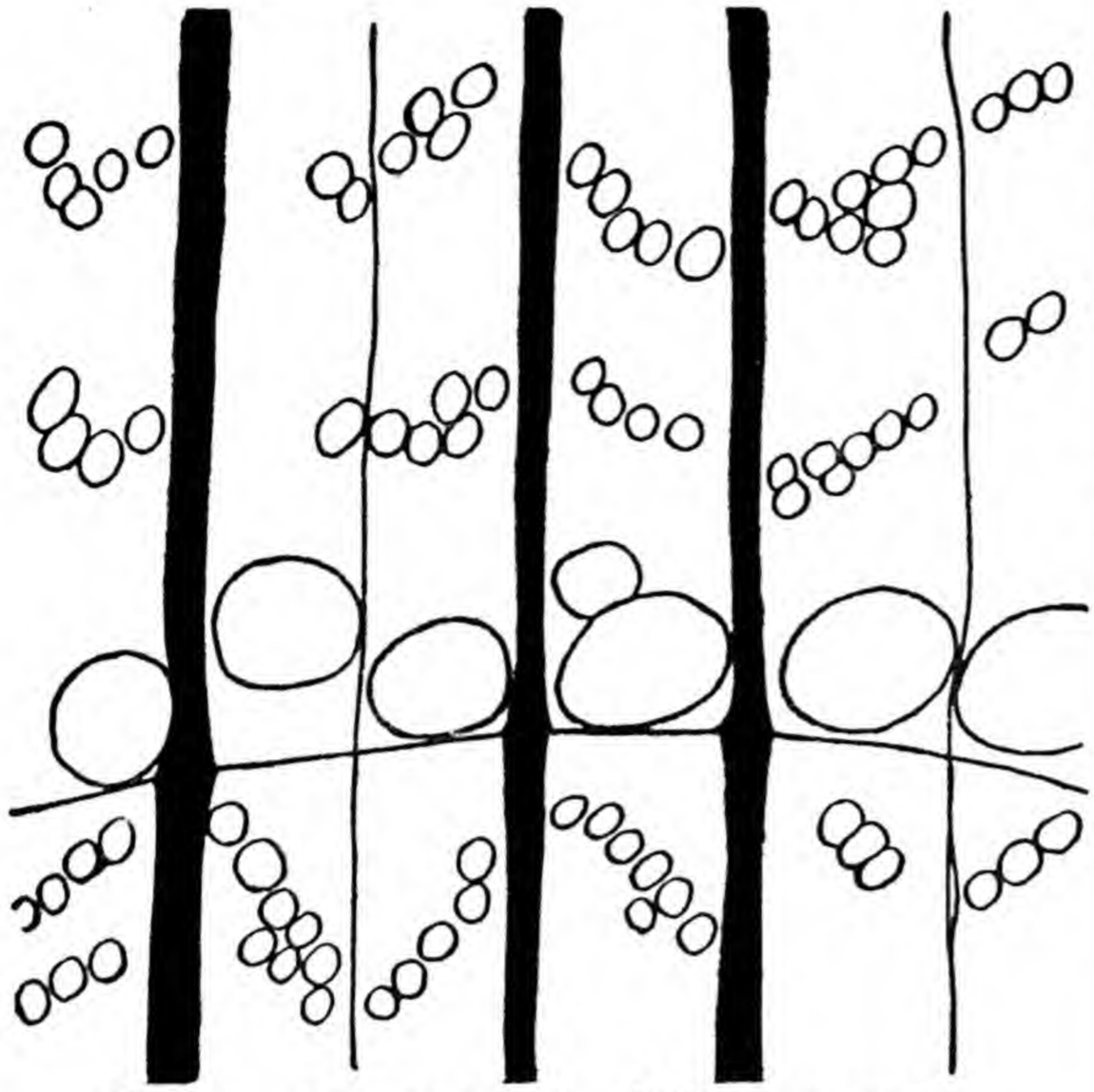

Fig. 12. COMMON ELM. (*Ulmus procera*).

Transverse Section :

Ring-porous.

Vessels somewhat round in the spring wood, arranged in one to three or more rows with a slight tendency to be in undulating tangential lines. Vessels in the summer wood arranged in undulating tangentially arranged groups.

Rays prominent, slightly noded at the crossing of the end of the season's growth.

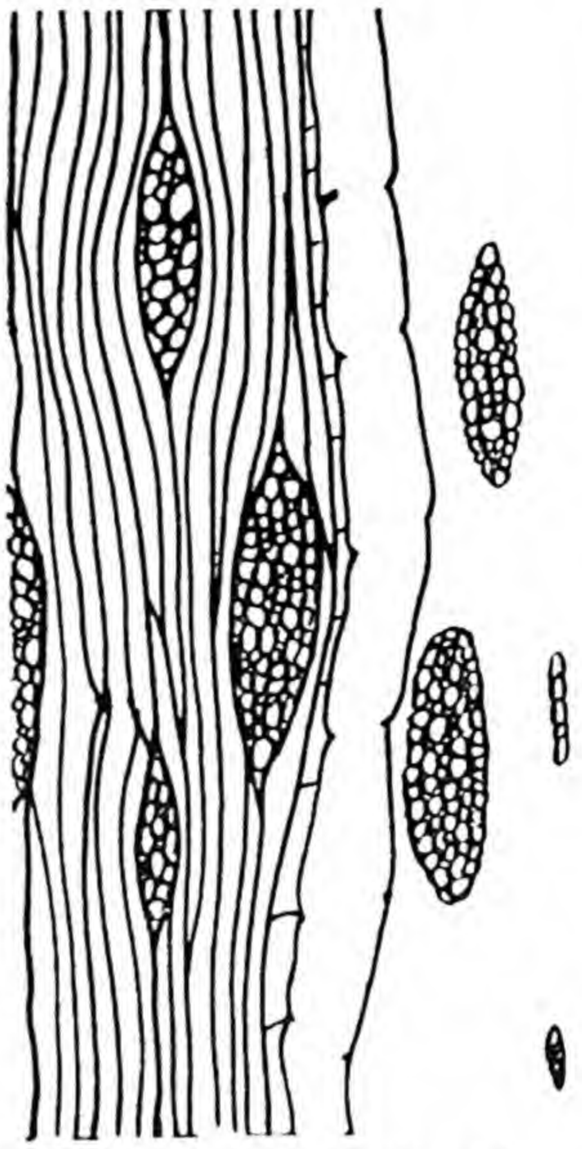

Fig. 13. COMMON ELM (*Ulmus procera*).

Tangential Section :

Rays prominent, thick-walled, low and wide.

Fibres thick-walled, curving round the rays.

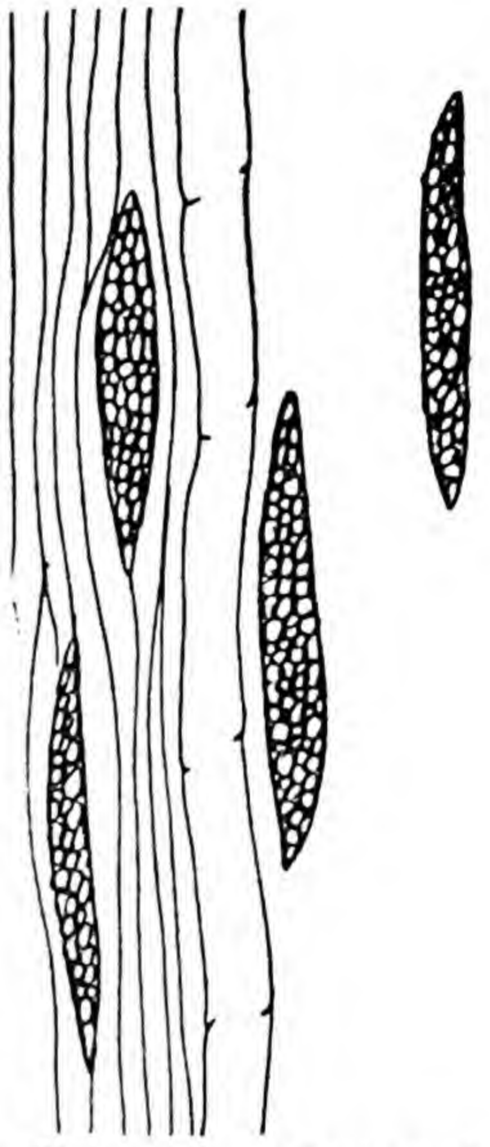

Fig. 14. WYCH ELM (*Ulmus glabra*).

Tangential Section :

Rays fairly high, narrow, not so thick-walled.

Fibres finer and not so undulating as in common elm.

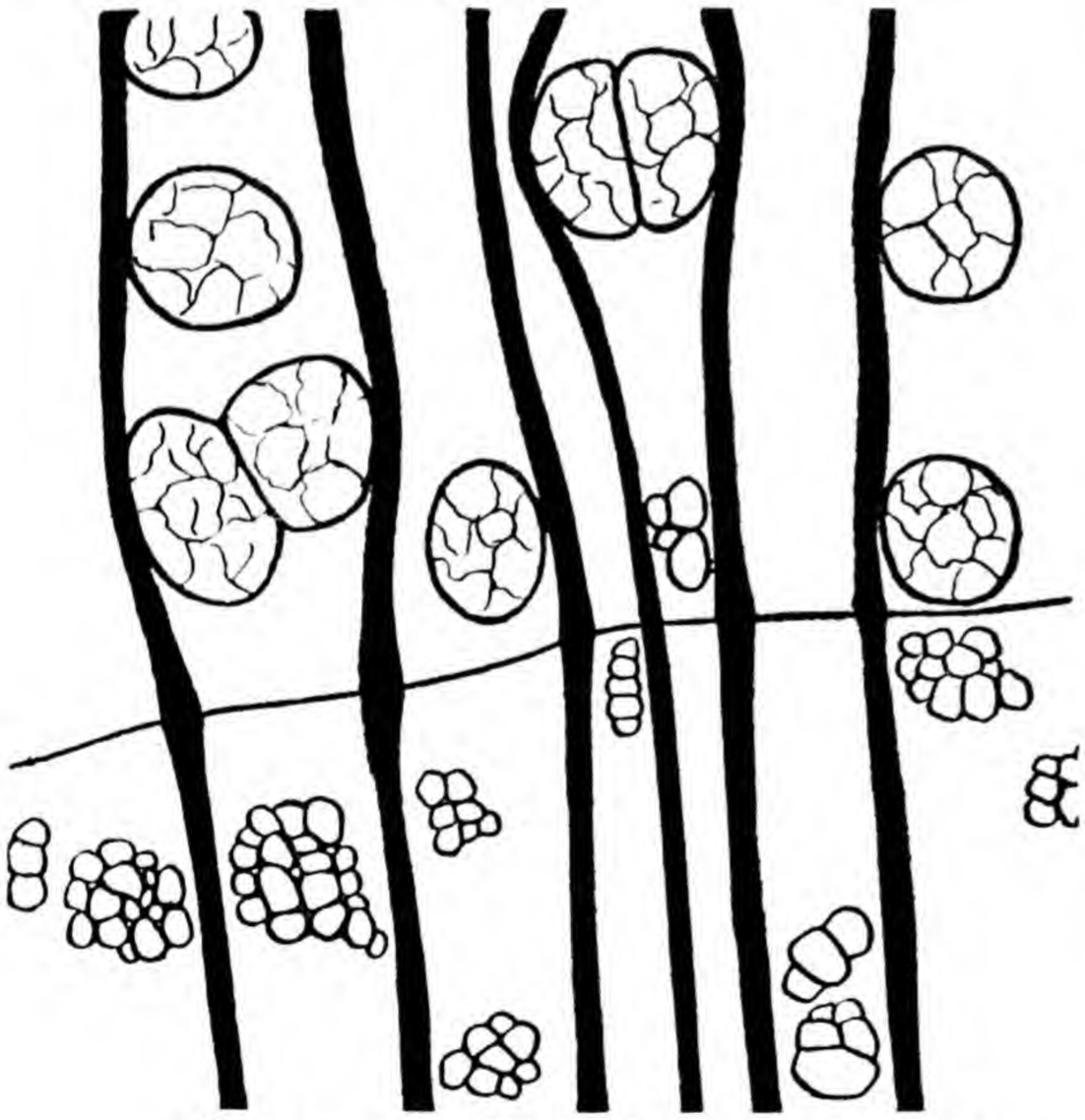

Fig. 15. ROBINIA (*Robinia pseudoacacia*).

Transverse Section :

Ring-porous or half-ring-porous wood.

Vessels in spring growth large ; single or in pairs. Smaller vessels sometimes present in groups. Tyloses abundant. Vessels in summer wood numerous, in clusters.

Rays fairly prominent, slightly noded where crossing the end of the season's growth.

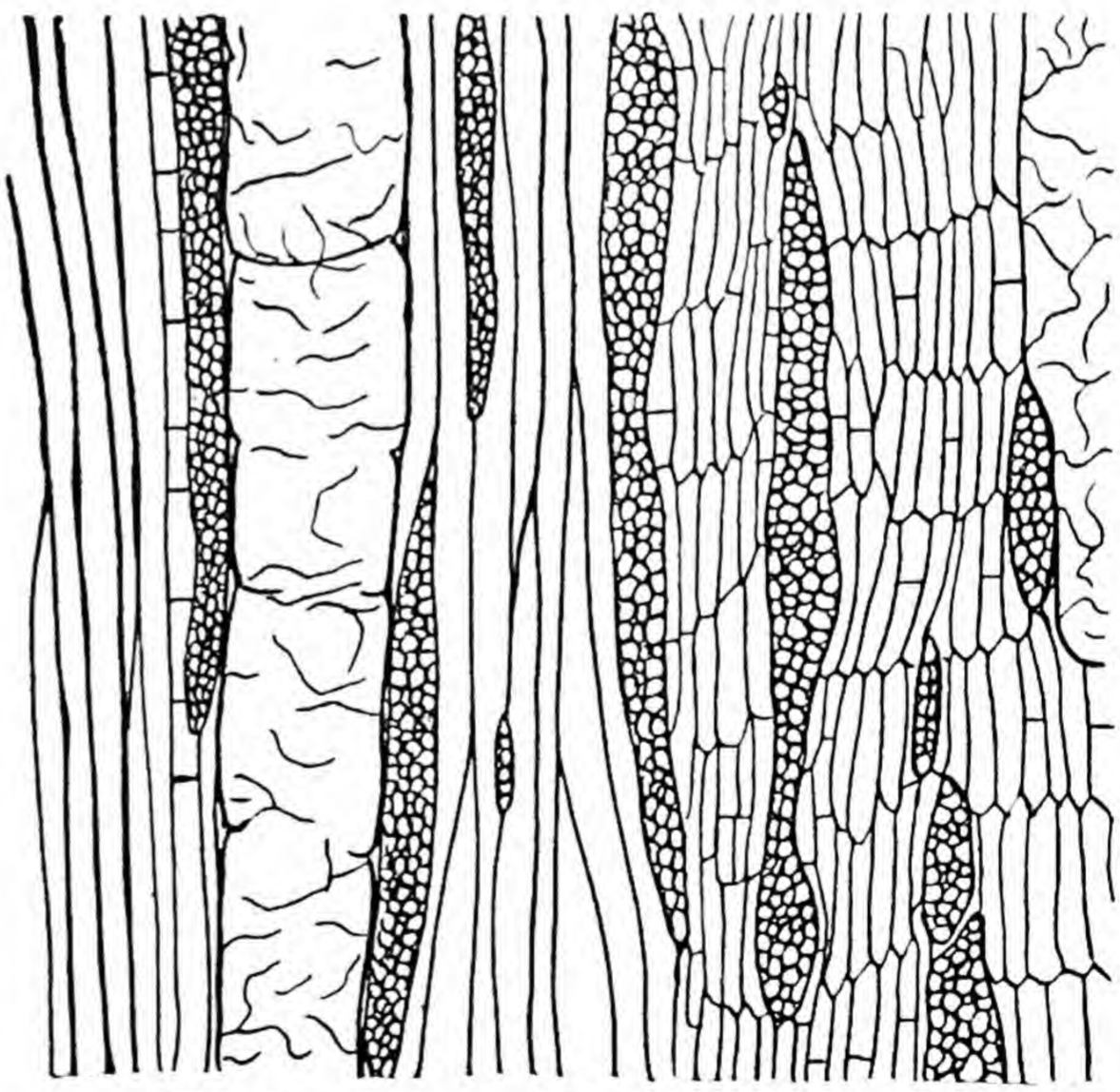

Fig. 16. ROBINIA (*Robinia pseudoacacia*).

Tangential Section :

Vessels with simple perforations. Abundant tyloses.

Rays often irregular in shape, fairly high ; some low rays present.

Parenchyma abundant, storied (tier-like).

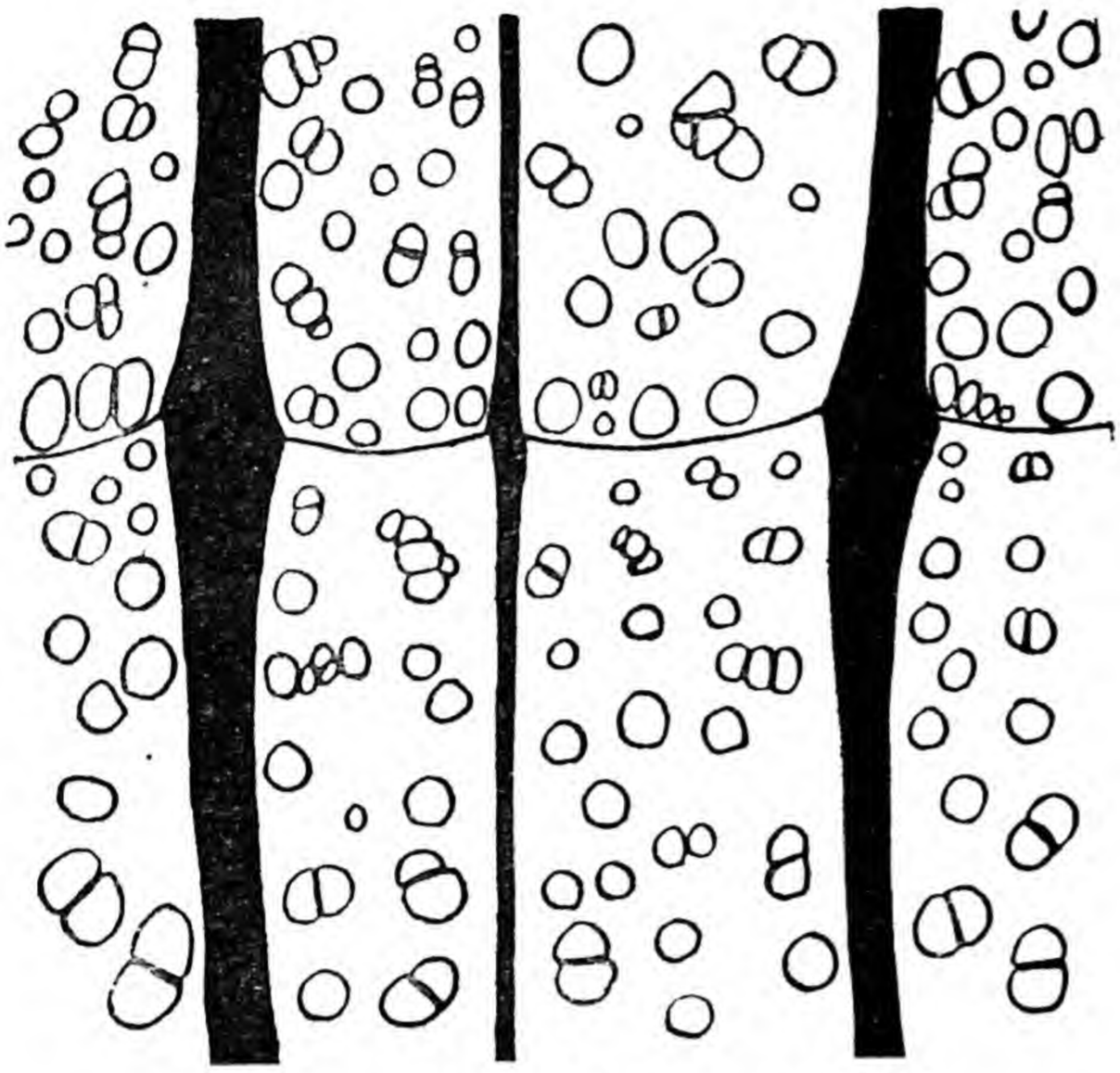

Fig. 17. PLANE (*Platanus acerifolia*).

Transverse Section :

Diffuse-porous.

Vessels small, numerous, scattered throughout the year's growth, sometimes in radial and tangential groups.

Rays prominent, large and abundant, noded where they cross the end of the season's growth. Annual rings dip from ray to ray.

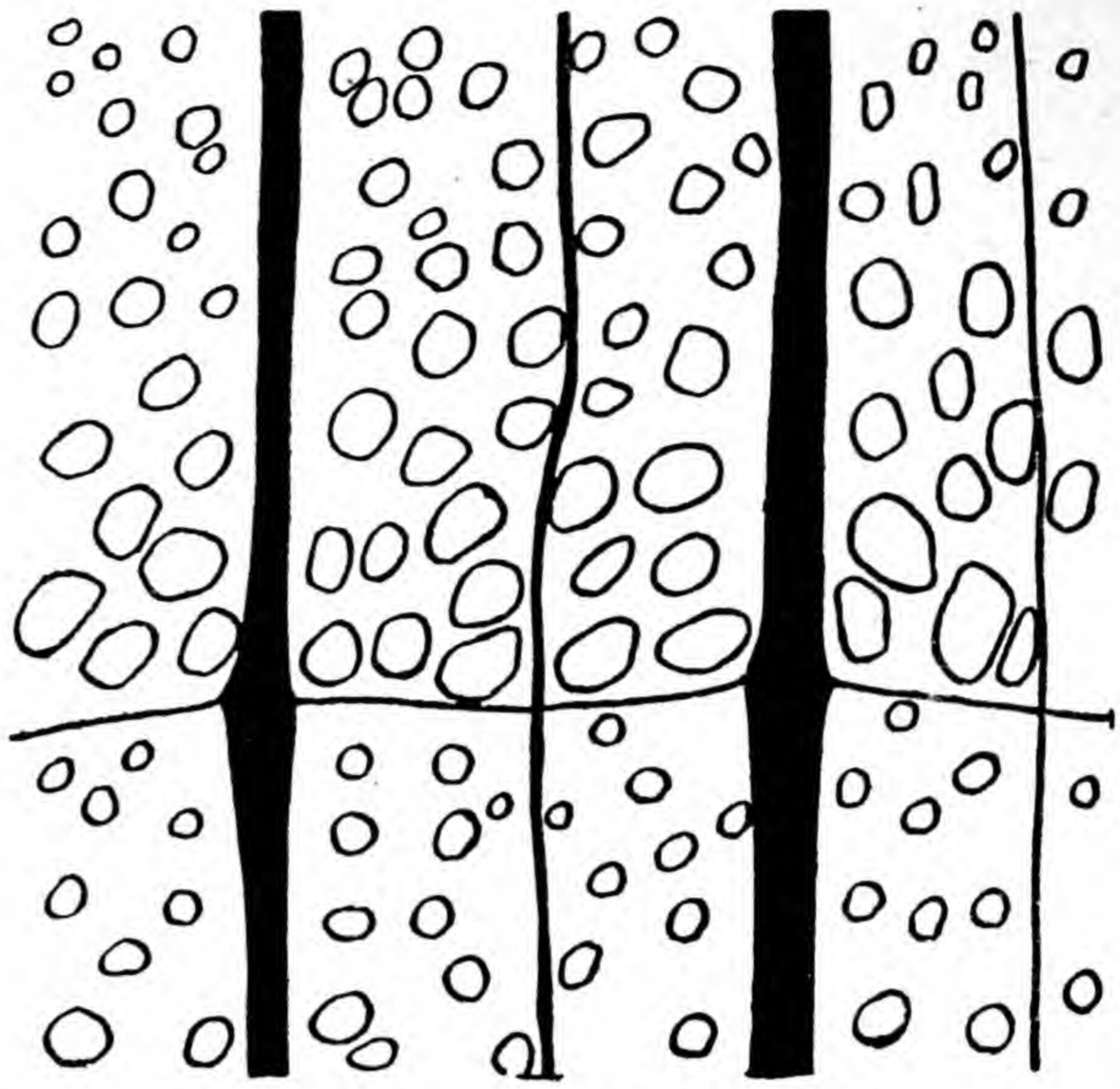

Fig. 18. BEECH (*Fagus sylvatica*).

Transverse Section :

Diffuse-porous wood.

Vessels numerous, irregularly shaped, gradually diminishing from spring to summer growth.

Rays of two sizes—large and small, the former are noded where they cross over the end of the season's growth.

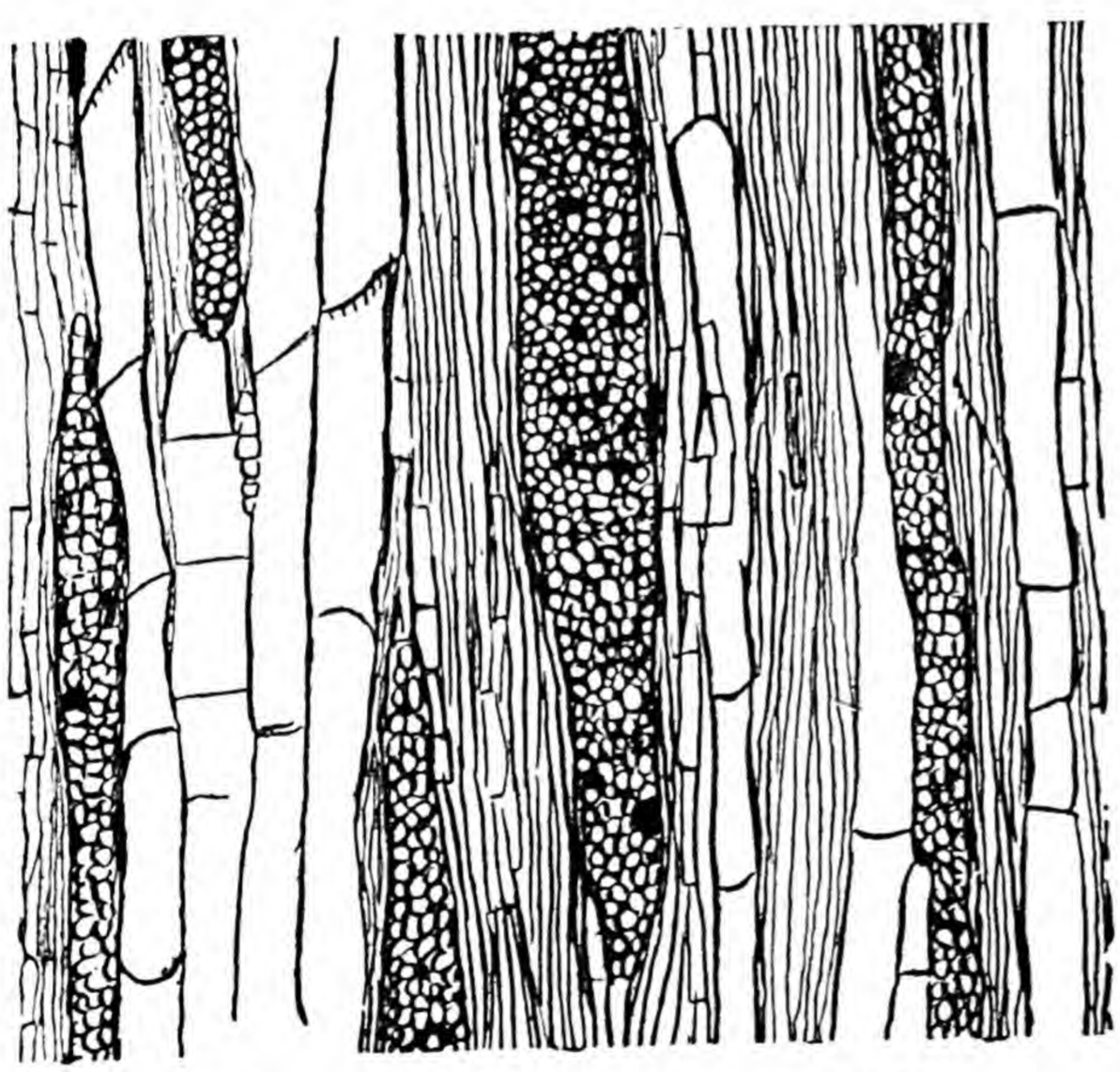

Fig. 19. PLANE (*Platanus acerifolia*).

Tangential Section :

Vessels with simple, and occasionally scalariform perforations.

Rays prominent, high, and with small, thick-walled cells.

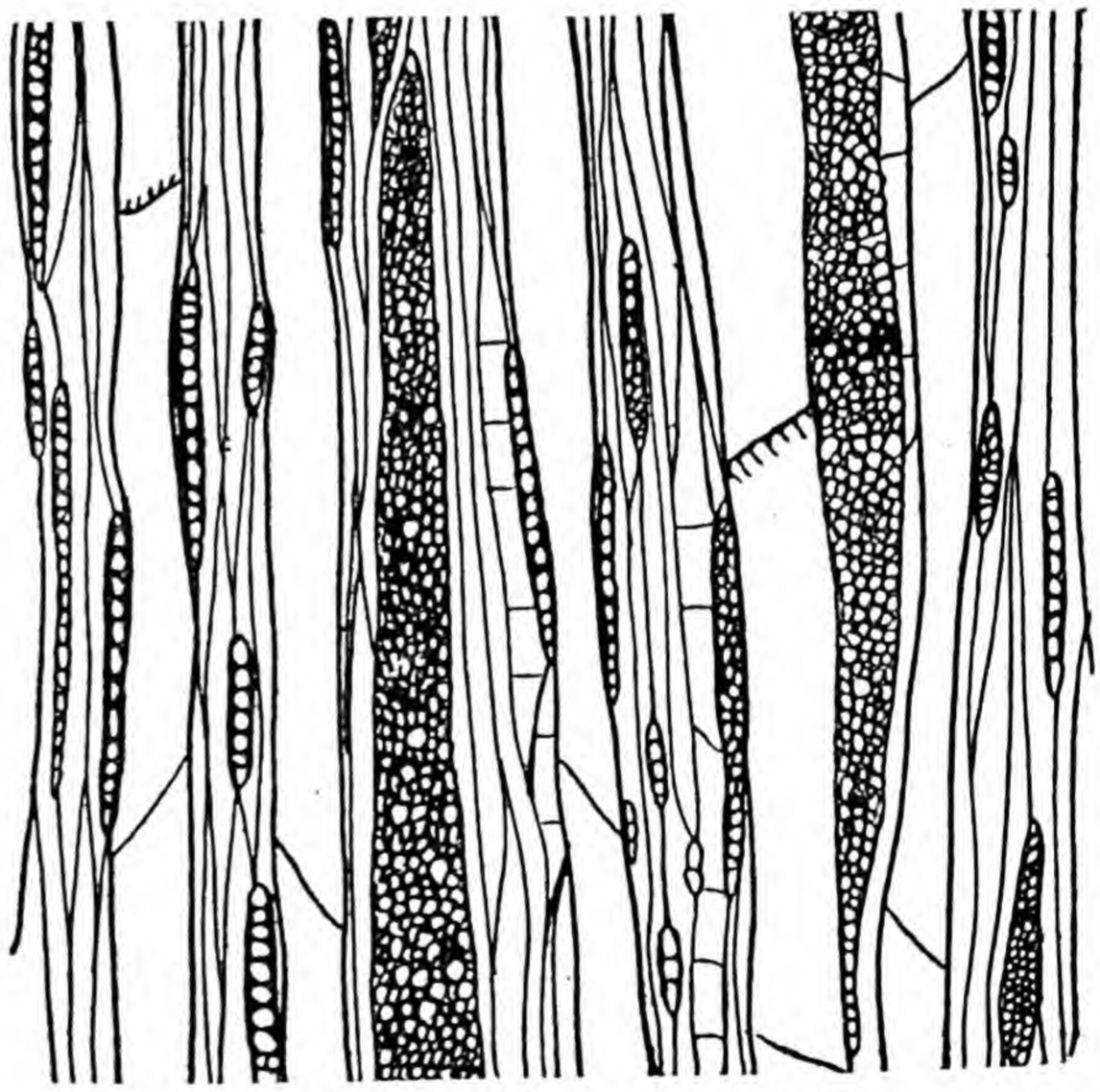

Fig. 20. BEECH (*Fagus sylvatica*).

Tangential Section :

Vessels. Simple perforations predominating. Scalariform perforations sometimes present.

Rays high, with small cells evenly distributed over the section ; numerous small rays one or two cells wide.

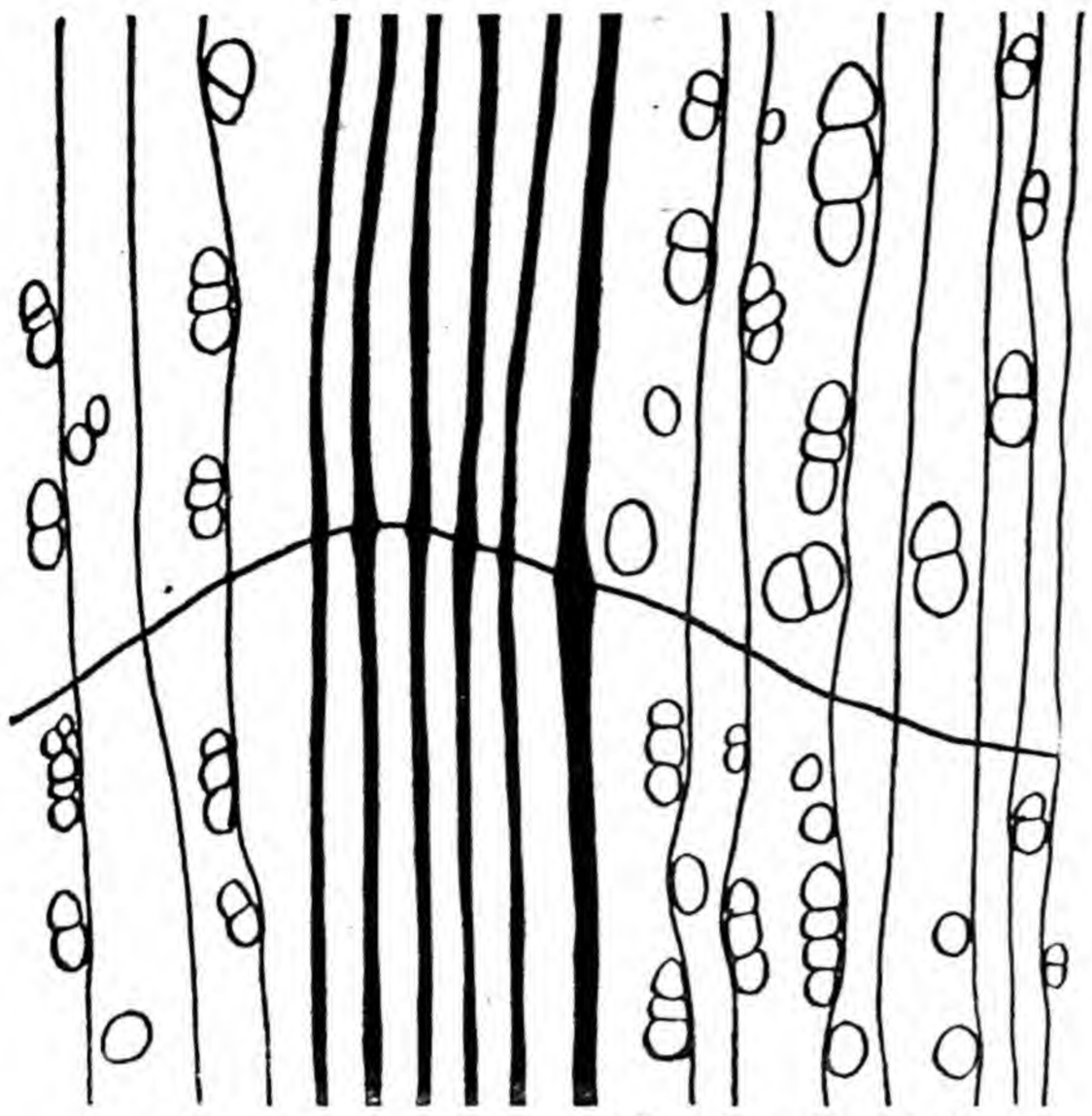

Fig. 21. HORNBEAM (*Carpinus Betulus*).

Transverse Section :

Diffuse-porous.

Vessels small and in radial arrangement ; not quite so angular as alder and birch.

Rays two types : (*a*) *aggregated* rays which are prominent and noded where they cross the end of the season's growth. Growth ring undulates when crossing aggregated rays. (*b*) fine rays, which are numerous.

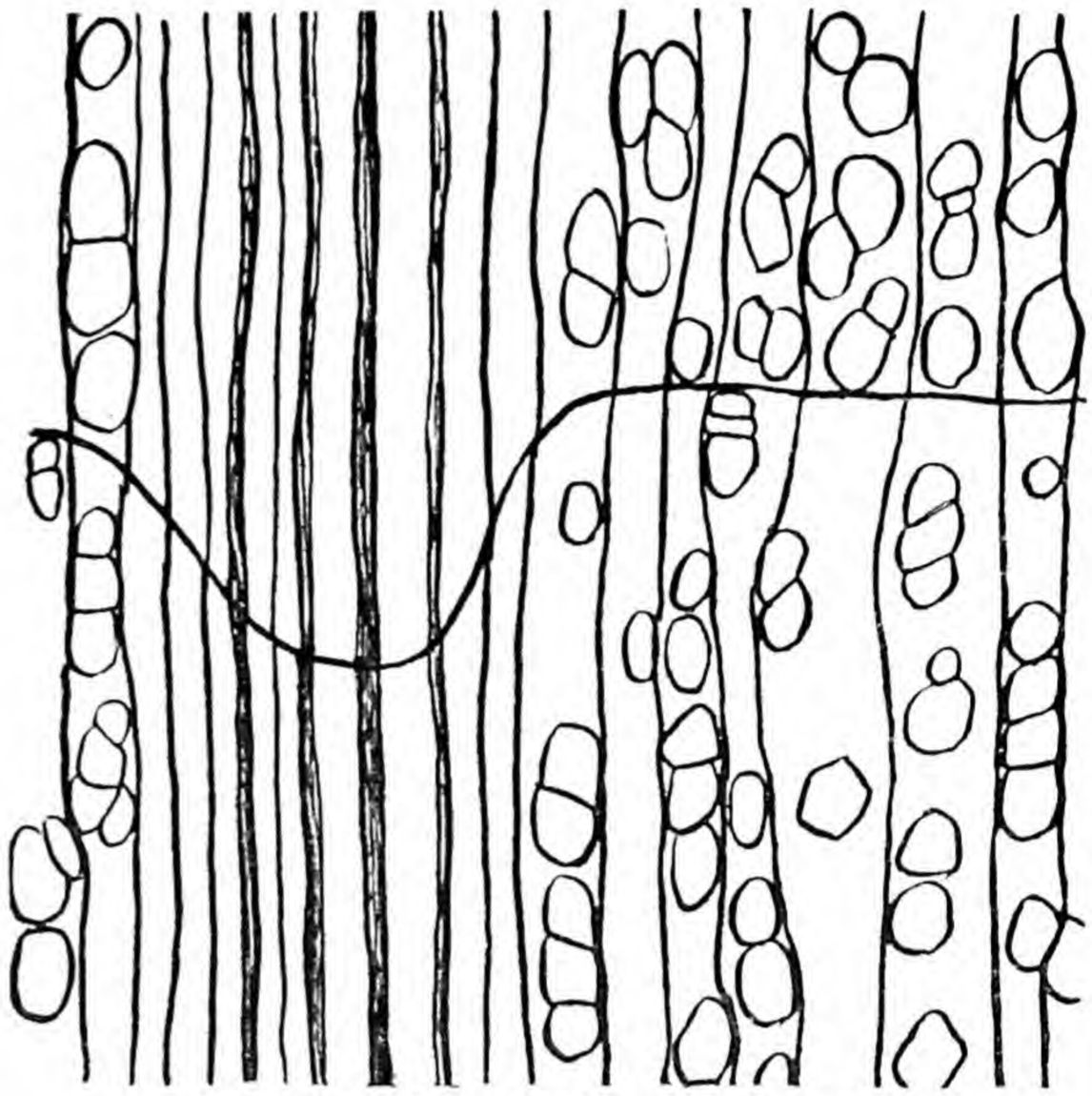

Fig. 22. ALDER (*Alnus glutinosa*).

Transverse Section :

Diffuse-porous, little demarcation between spring and summer wood. The growth ring dips characteristically where it crosses the aggregated rays.

Vessels somewhat angular, arranged chiefly in radial groups.

Rays of two kinds, namely : (*a*) *aggregated*, consisting of a series of rays collected together, which, in the solid, appear as one large ray. (*b*) *rays not in aggregation*, one and two cells wide. These are very widely spaced and may be absent over considerable areas.

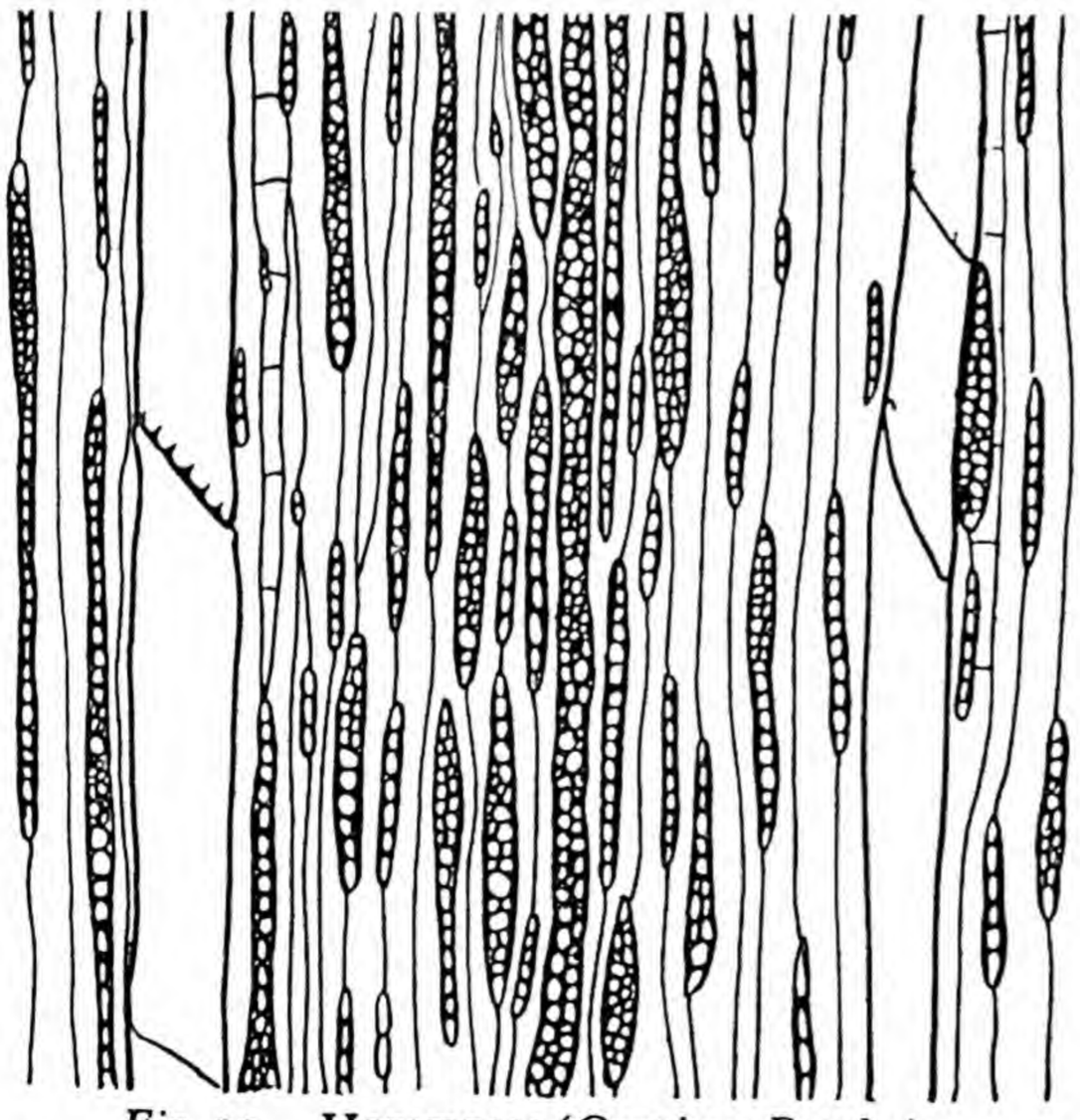

Fig. 23. HORNBEAM (*Carpinus Betulus*).

Tangential Section :

Vessels with simple perforations predominating, scalariform perforations sometimes present.

Rays aggregated. Rays forming aggregation fairly regular in shape, often high. Rays not in aggregation, chiefly one and two cells wide.

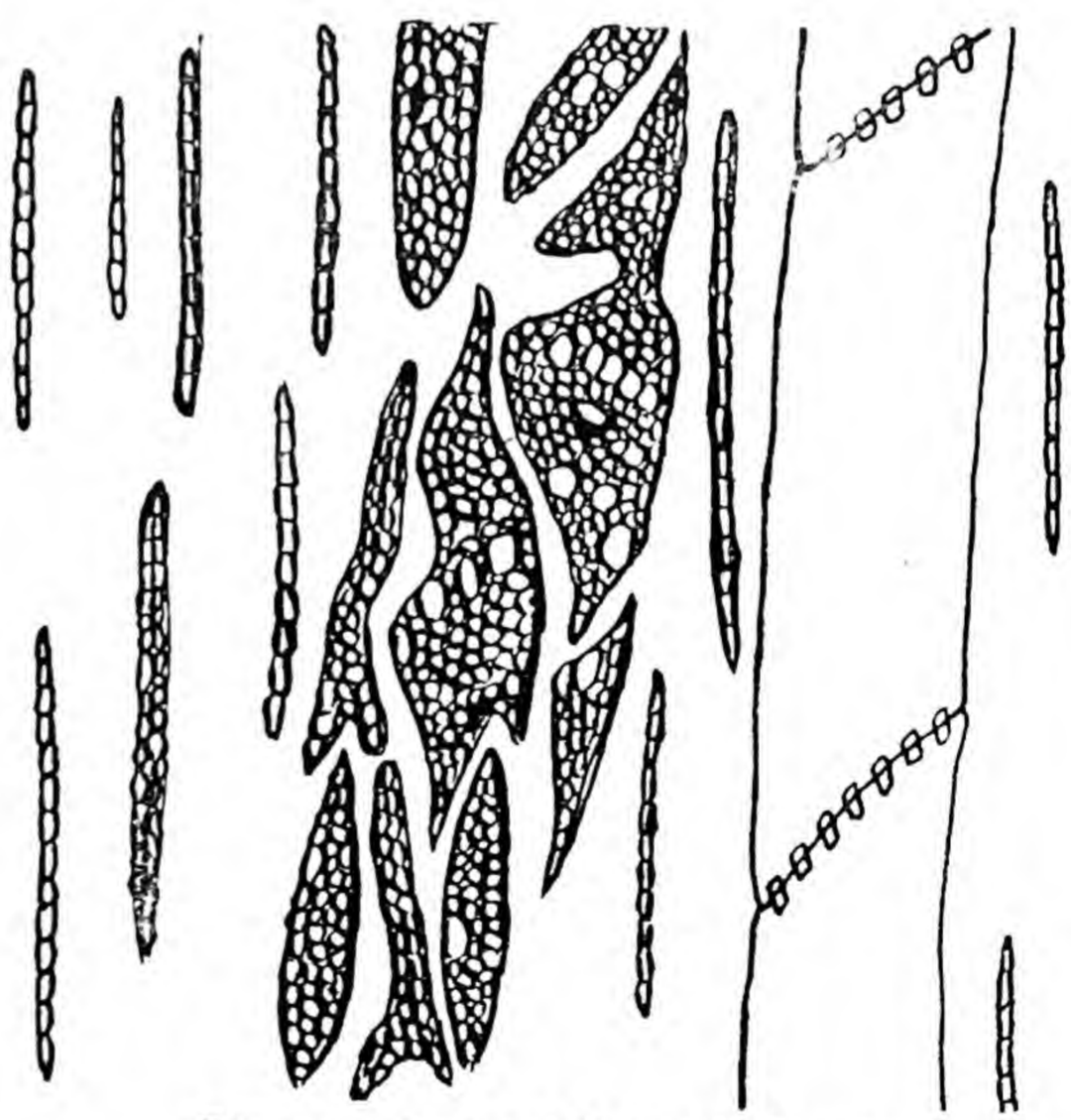

Fig. 24. ALDER (*Alnus glutinosa*).

Tangential Section :

Vessels with scalariform perforations.

Rays. In aggregated rays the individual rays are irregular in outline and arrangement.

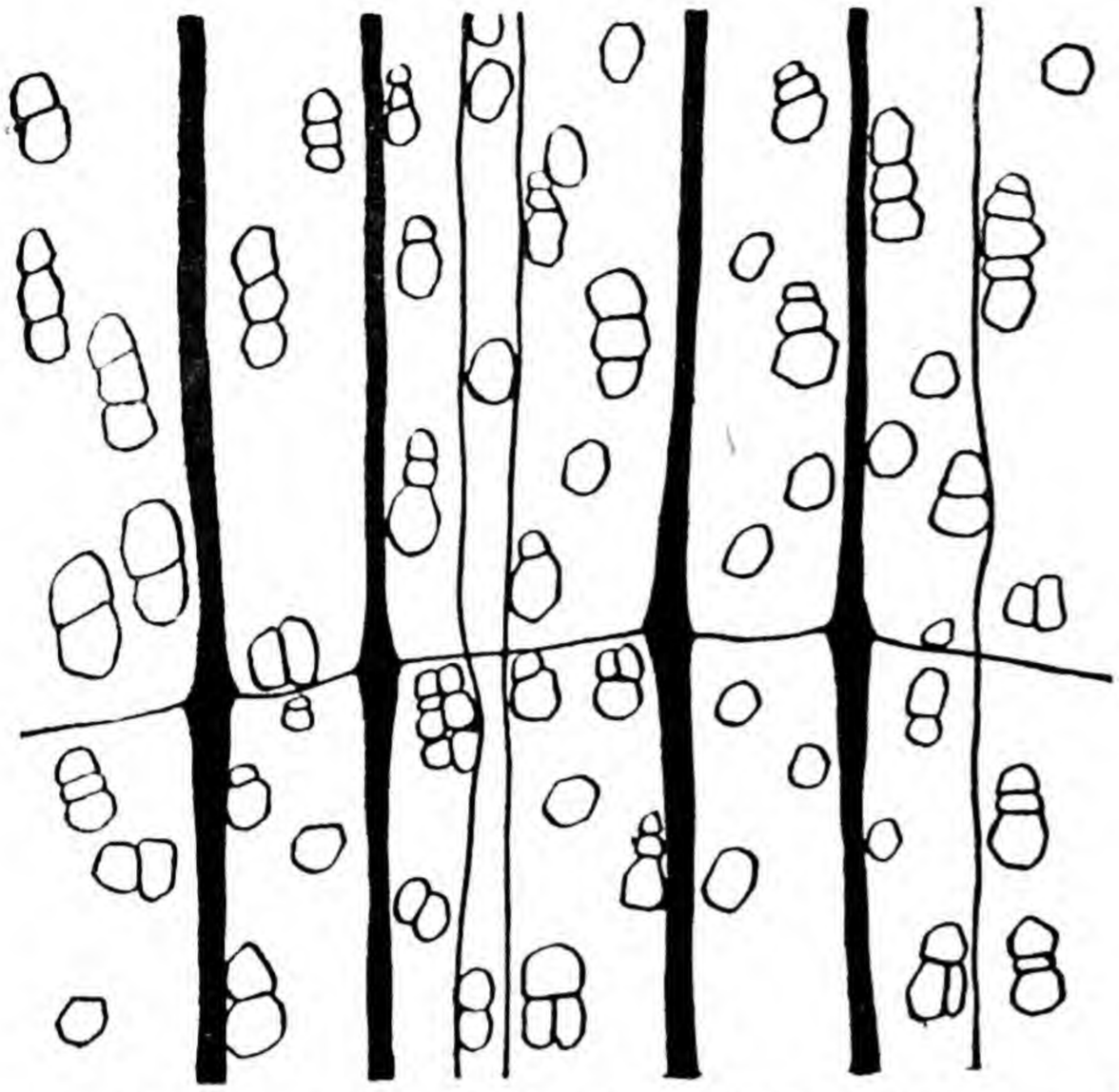

Fig. 25. BIRCH (? *Betula pendula* or *B. pubescens*).

Transverse Section :

Diffuse-porous wood.

Vessels somewhat angular, arranged in radial groups ; sometimes radially divided.

Rays fairly evenly distributed, fine, noded where they cross over the end of the season's growth.

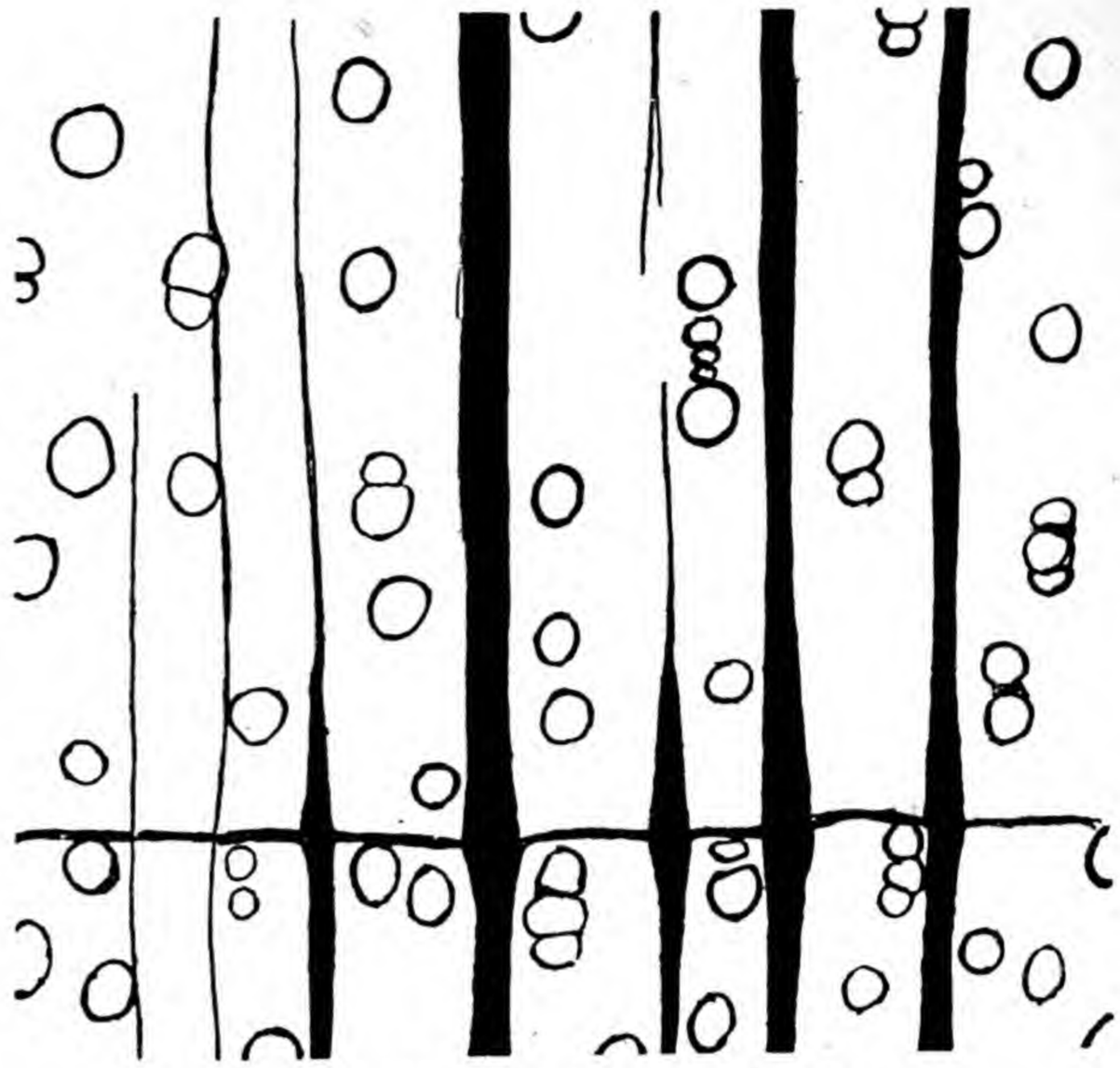

Fig. 26. SYCAMORE (*Acer pseudoplatanus*).

Transverse Section :

Diffuse-porous wood.

Vessels few and small, round, mostly single, or sometimes arranged in small radial groups, evenly distributed throughout ring.

Rays prominent, noded, very straight.

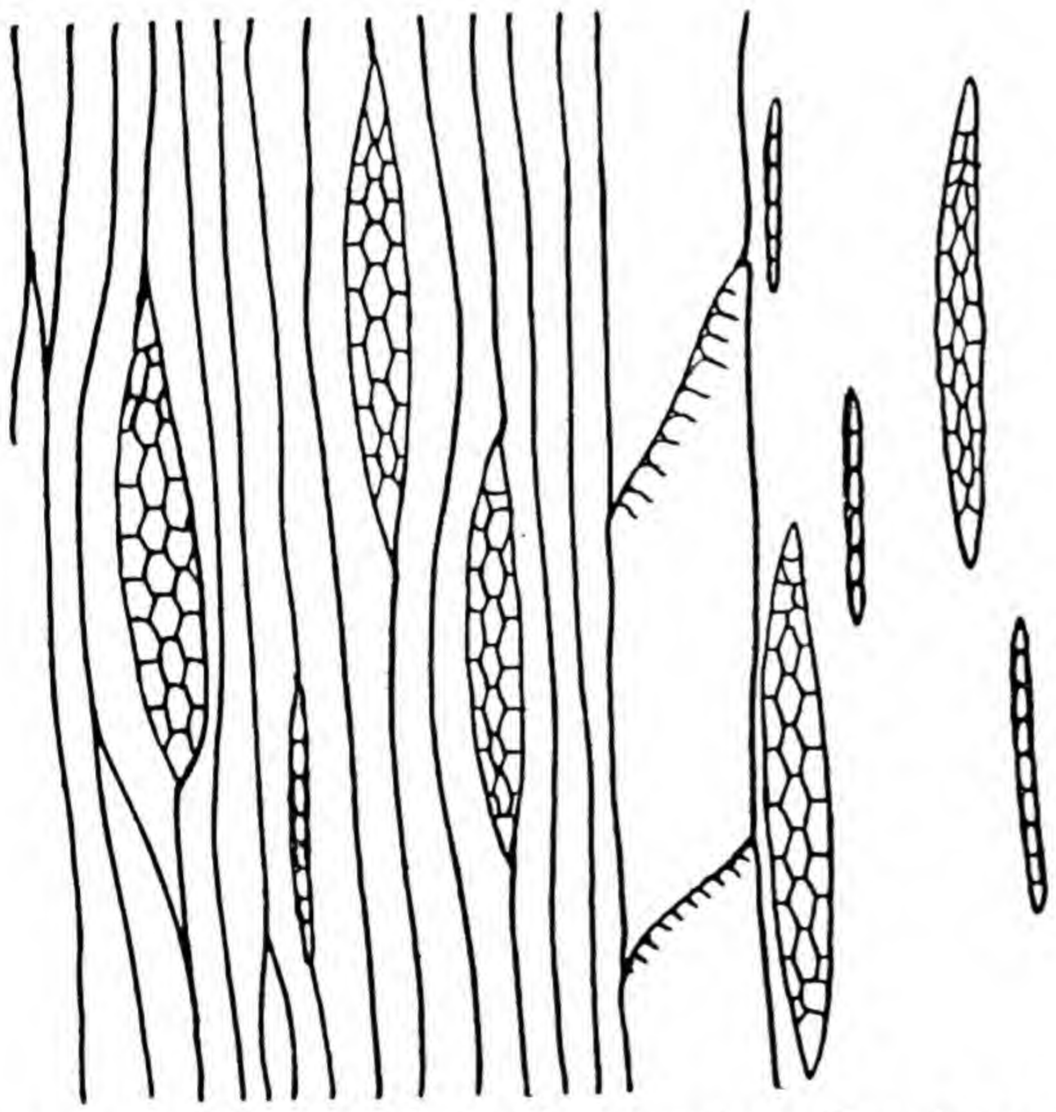

Fig. 27. BIRCH (? *Betula pendula* or *B. pubescens*).

Tangential Section :

Vessels with scalariform perforations.

Rays one to three, and (rarely four) cells wide. Ray cells often six-sided.

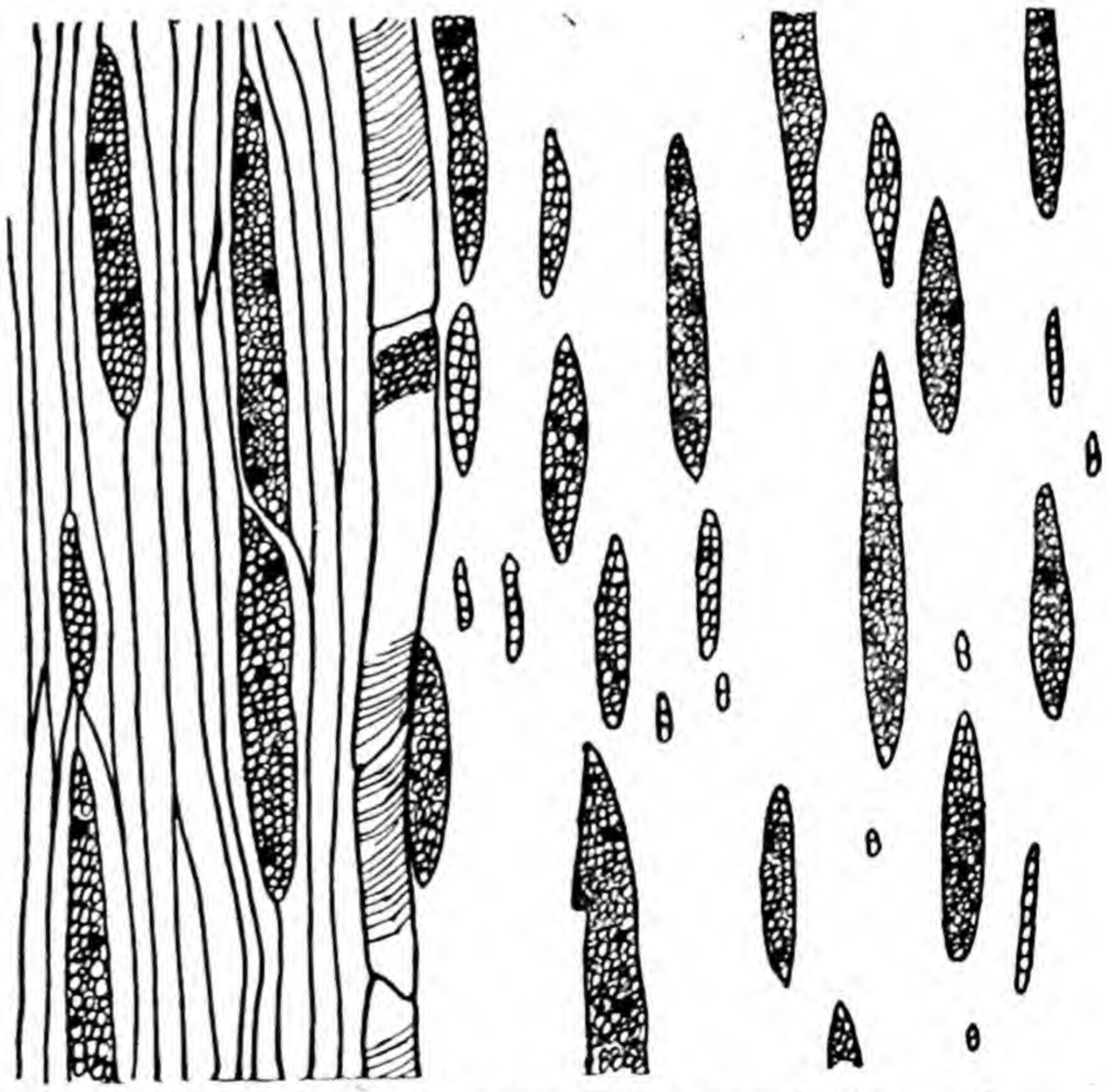

Fig. 28. SYCAMORE (*Acer pseudoplatanus*).

Tangential Section :

Vessels with simple perforations, spiral thickening abundant, bordered pits small, crowded.

Rays prominent ; medium to low in height, cell walls thick. Cells very rounded (compare with birch).

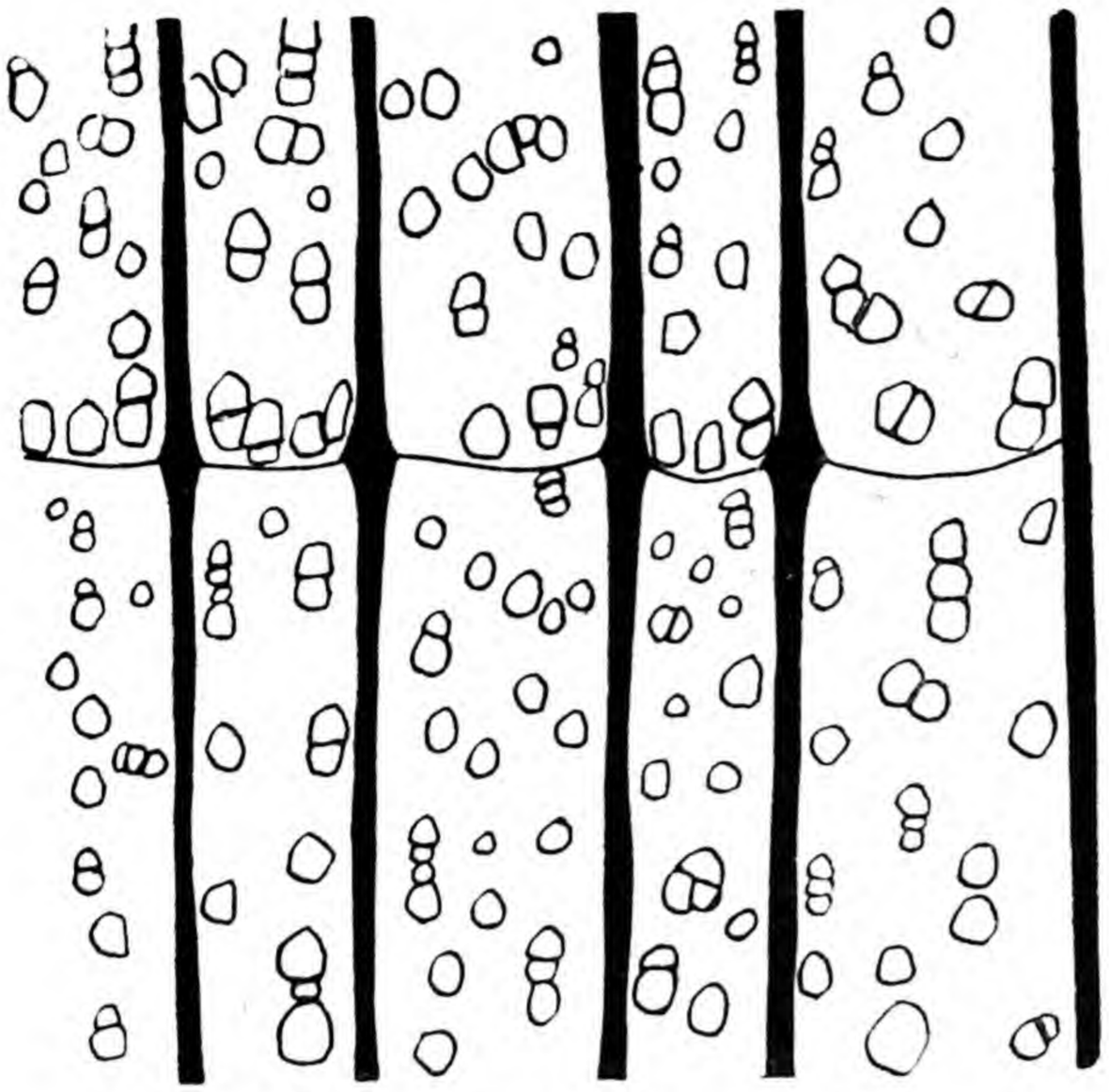

Fig. 29. CHERRY (*Prunus Avium*).

Transverse Section :

Diffuse-porous wood.

Vessels in radial, oblique, and tangential groups. Sometimes a tendency to form a small pore ring when the vessels are more abundant in the spring wood.

Rays prominent, in regular arrangement, noded where they cross the end of the season's growth.

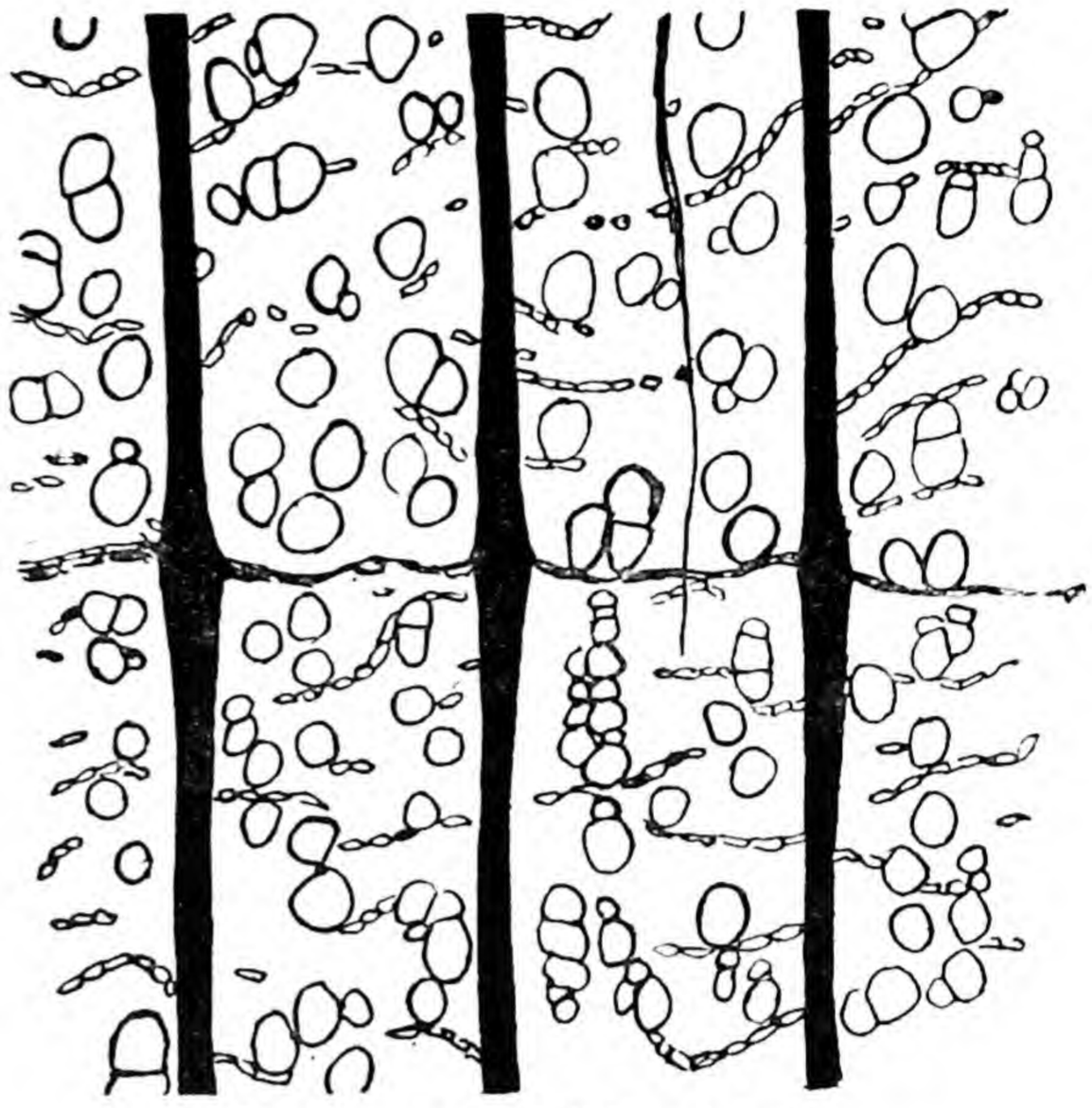

Fig. 30. LIME (*Tilia vulgaris*).

Transverse Section :

Diffuse-porous wood.

Vessels small, numerous and commonly arranged in radial, tangential and nested groups. Slight undulation of the growth ring.

Rays noded.

Parenchyma in short, broken tangential lines.

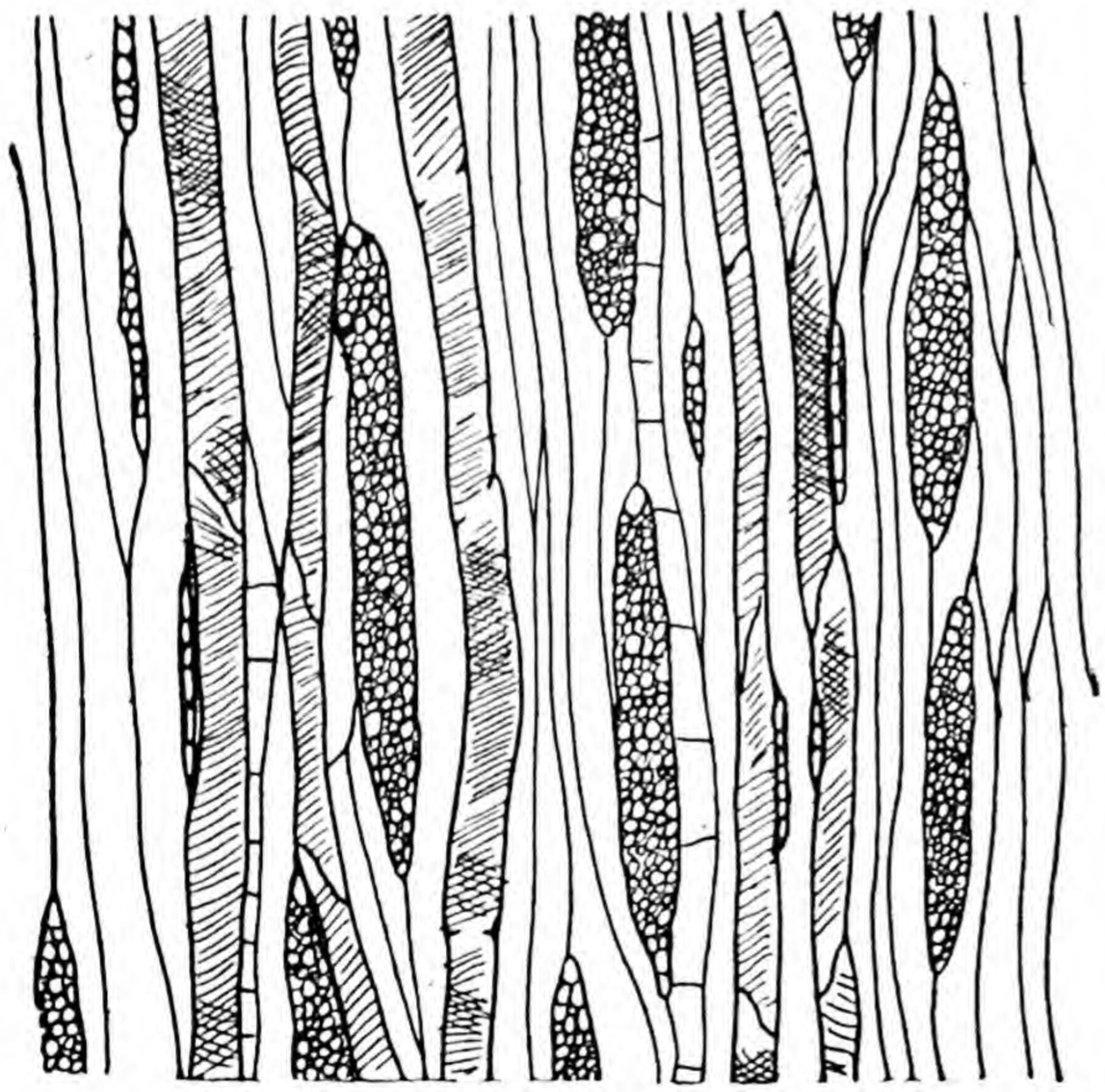

Fig. 31. CHERRY (*Prunus Avium*).

Tangential Section :

Vessels with spiral thickening.

Rays 1–2 cells wide and 3–5 cells wide.

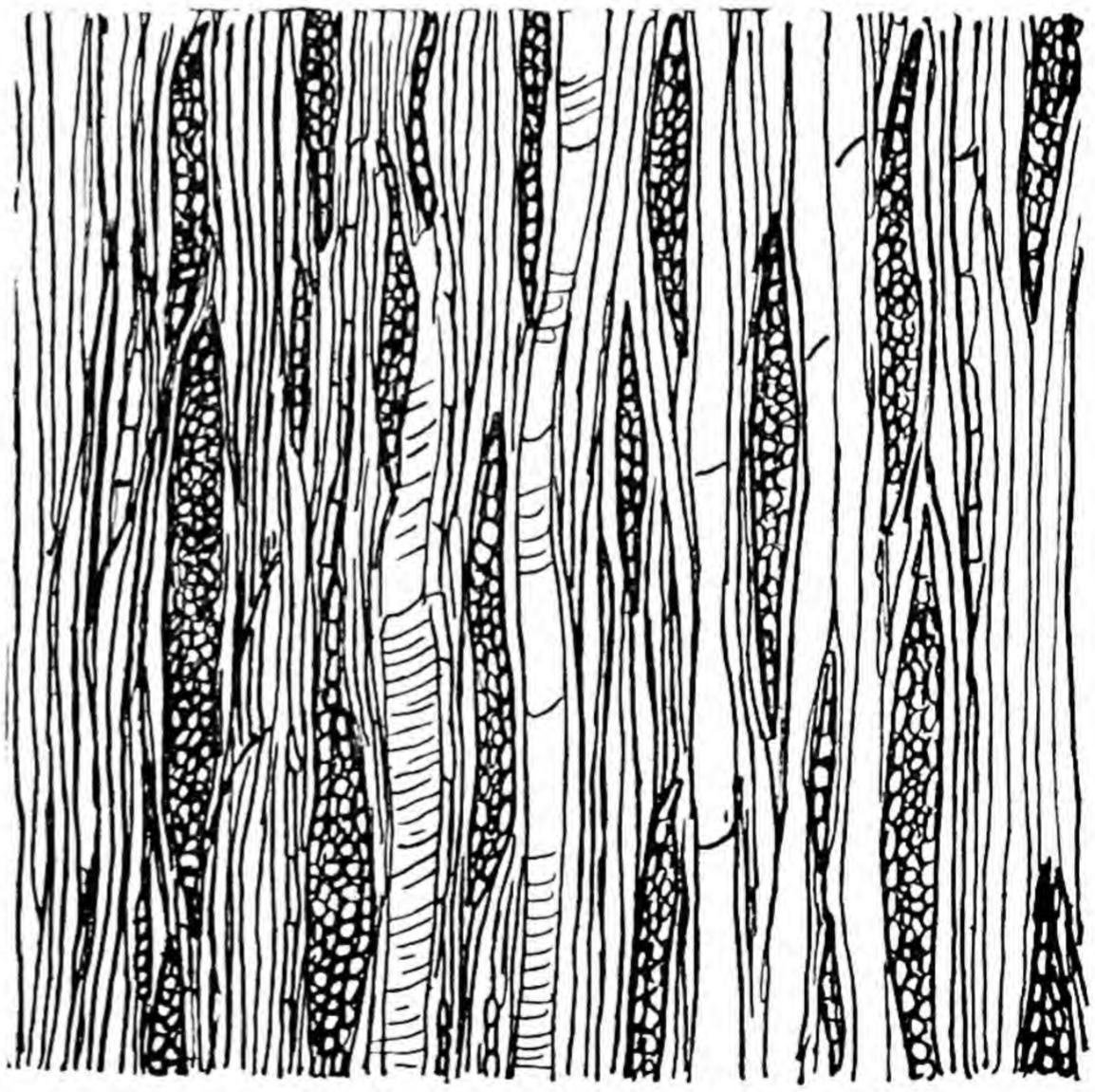

Fig. 32. LIME (*Tilia vulgaris*).

Tangential Section :

Vessels simple perforations, spiral thickening present.

Rays numerous, asymmetrical.

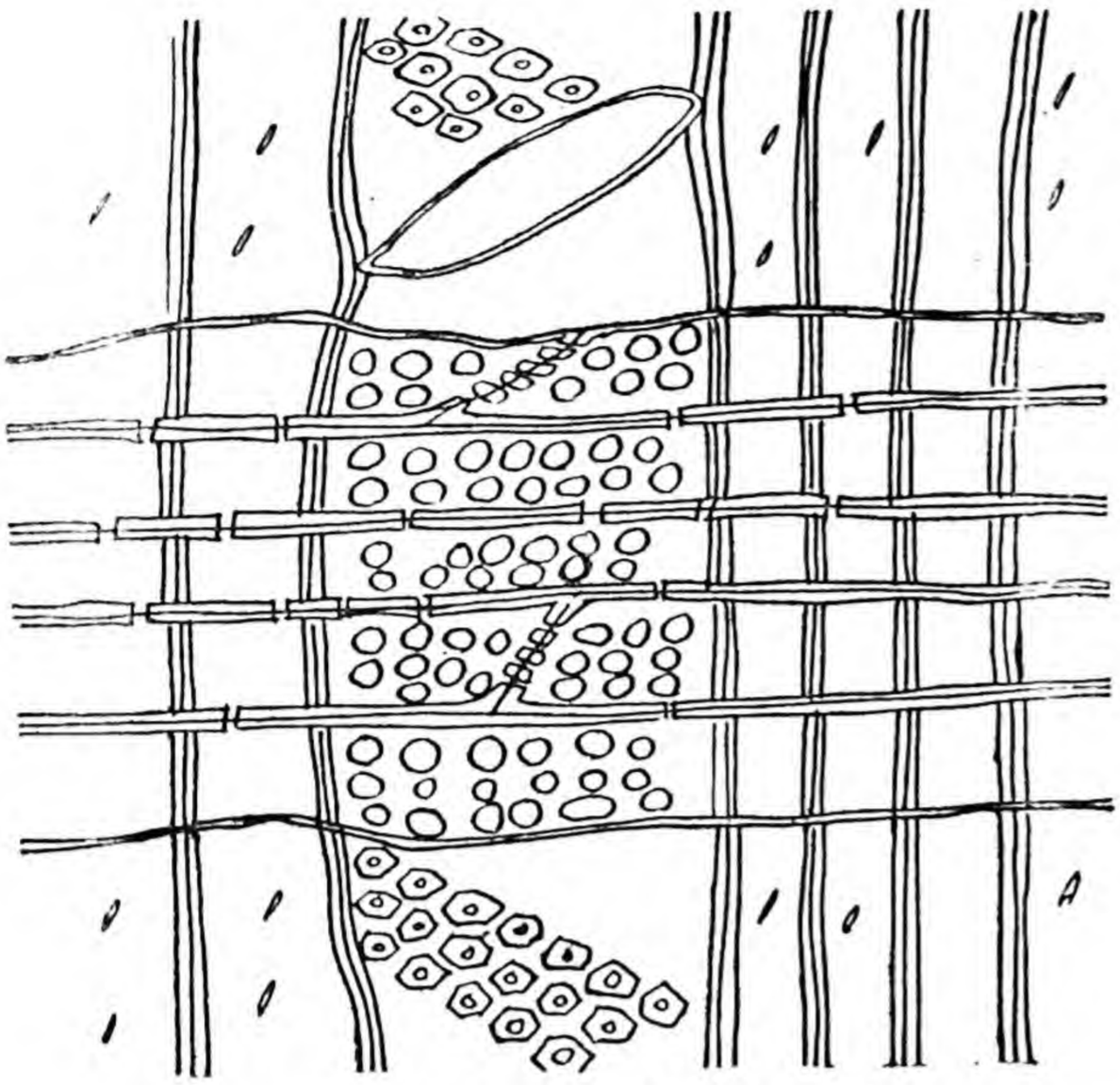

Fig. 33. POPLAR (*Populus* sp.).

Radial Section :

Vessels with simple perforations ; bordered pits crowded, angular and in spiral arrangement.

Rays simple pits numerous on all walls, on radial walls arranged in twos and threes longitudinally. More or less homogeneous.

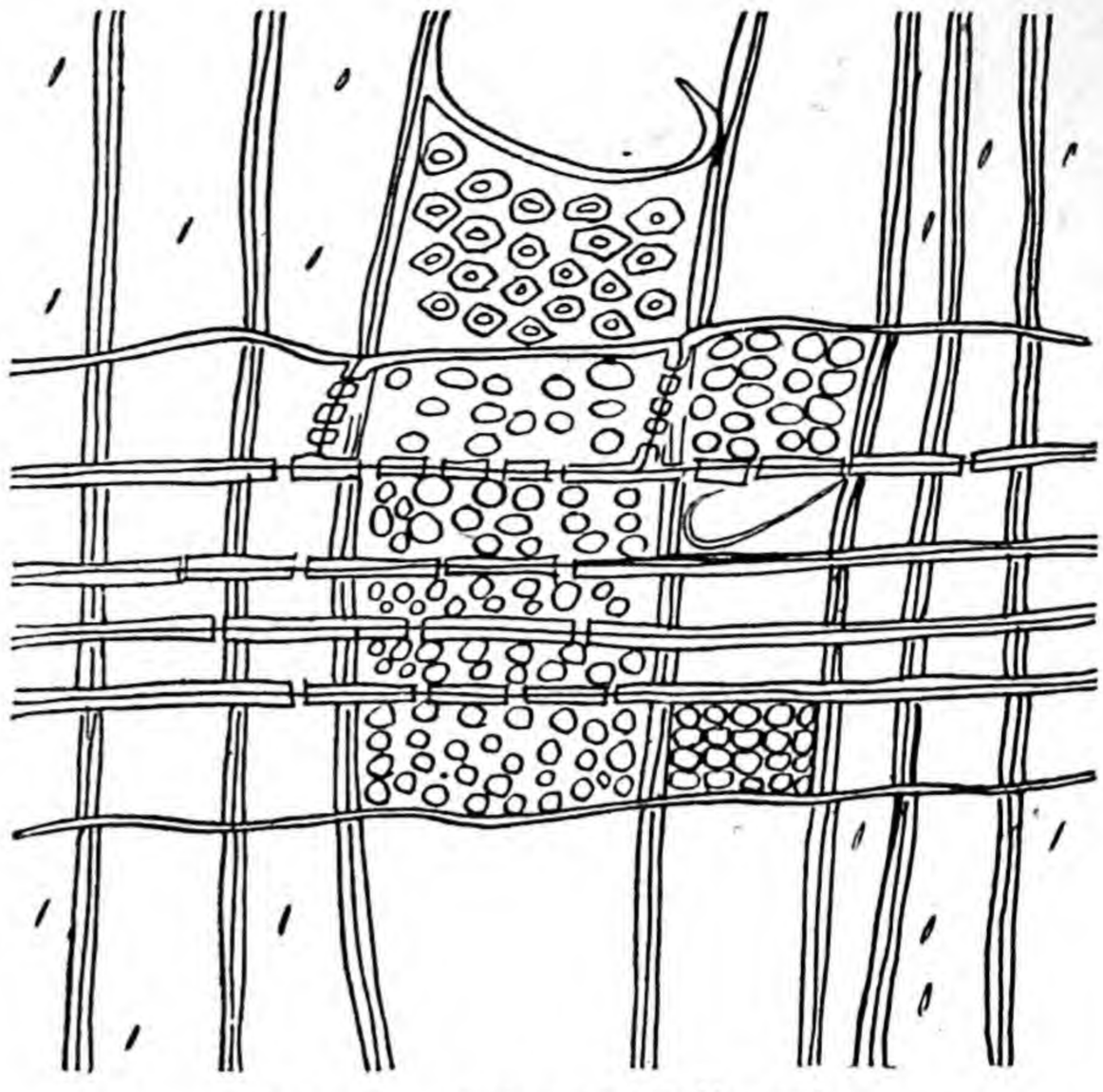

Fig. 34. WILLOW (*Salix* sp.).

Radial Section :

Vessels with simple perforations ; bordered pits not as angular as in poplar, arranged in spiral.

Rays simple pitting numerous on all walls, on radial walls, pits in twos, threes, and fives, arranged longitudinally. Heterogeneous.

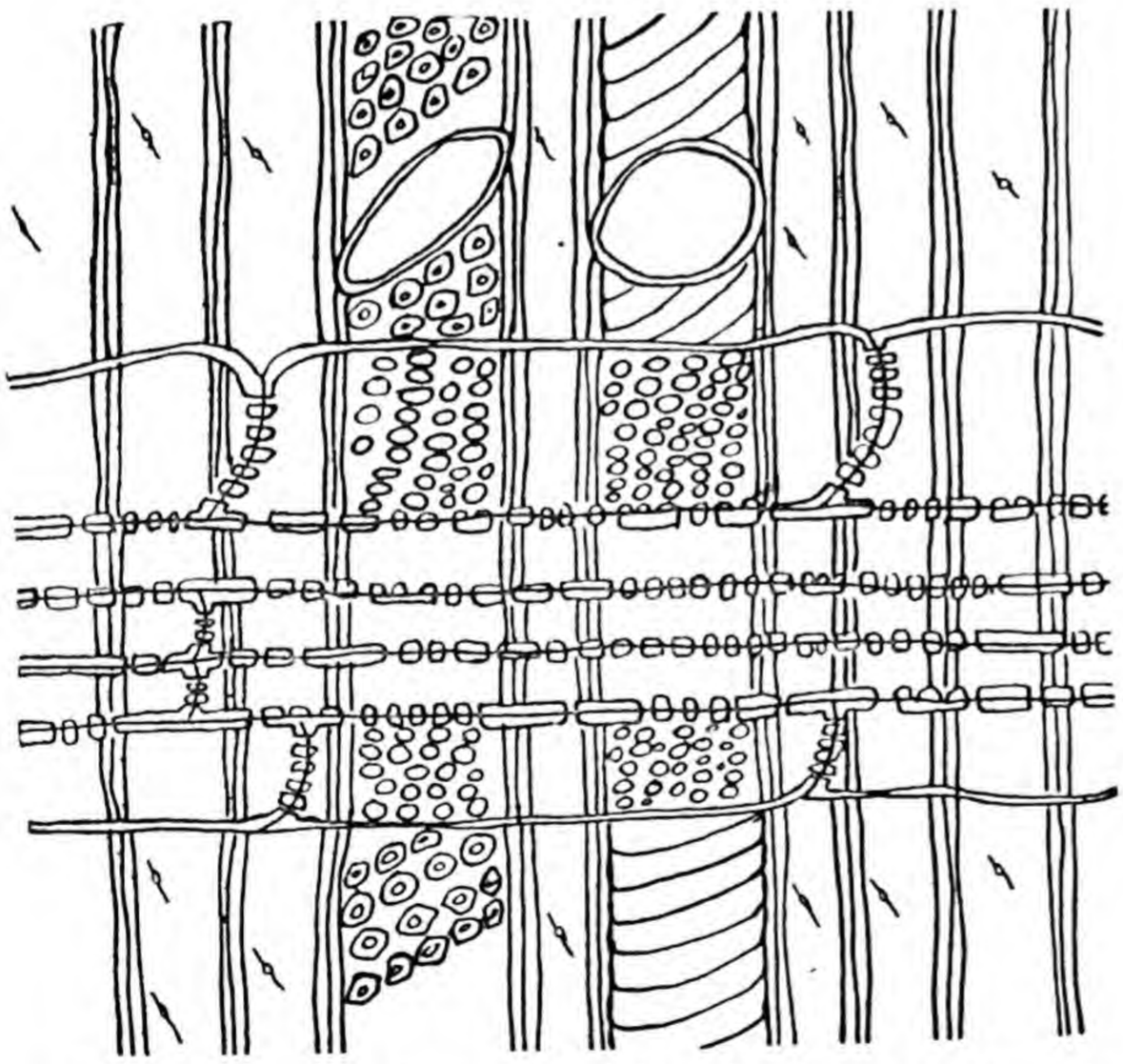

Fig. 35. HORSE CHESTNUT (*Aesculus Hippocastanum*).

Radial Section :

Vessels with simple perforations and spiral thickening. Bordered pits arranged in spiral.

Rays heterogeneous prominent edge cells. Simple pits abundant on all walls. The radial walls average 5–9 simple pits longitudinally.

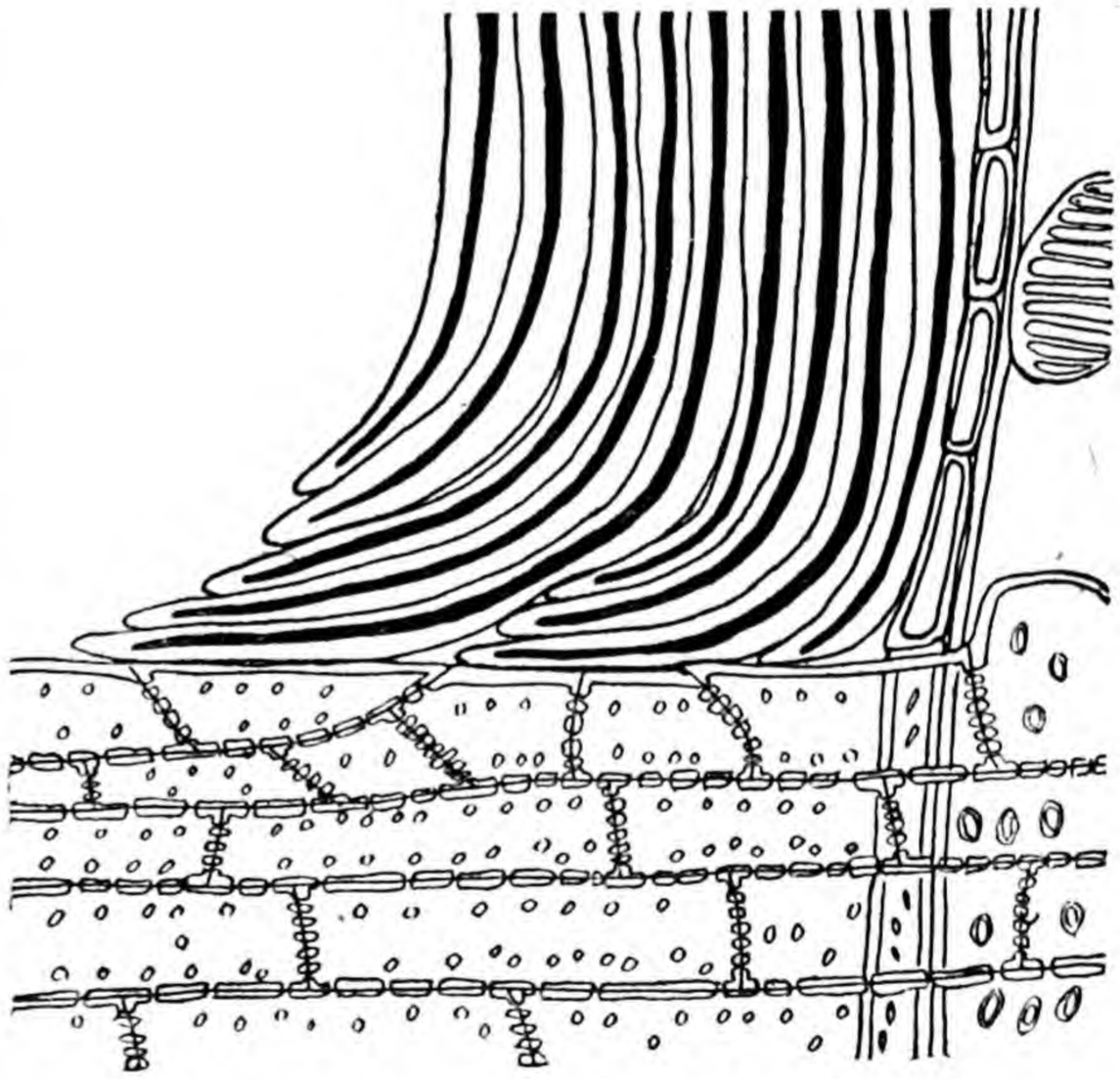

Fig. 36. BOX (*Buxus sempervirens*).

Radial Section :

Vessels exclusively with scalariform perforations, scalariform bars thick.

Rays thick-walled, heavily pitted on all walls ; edge cells prominent.

Fibres thick-walled, cavities small ; frequently turning in a horizontal direction along the rays.

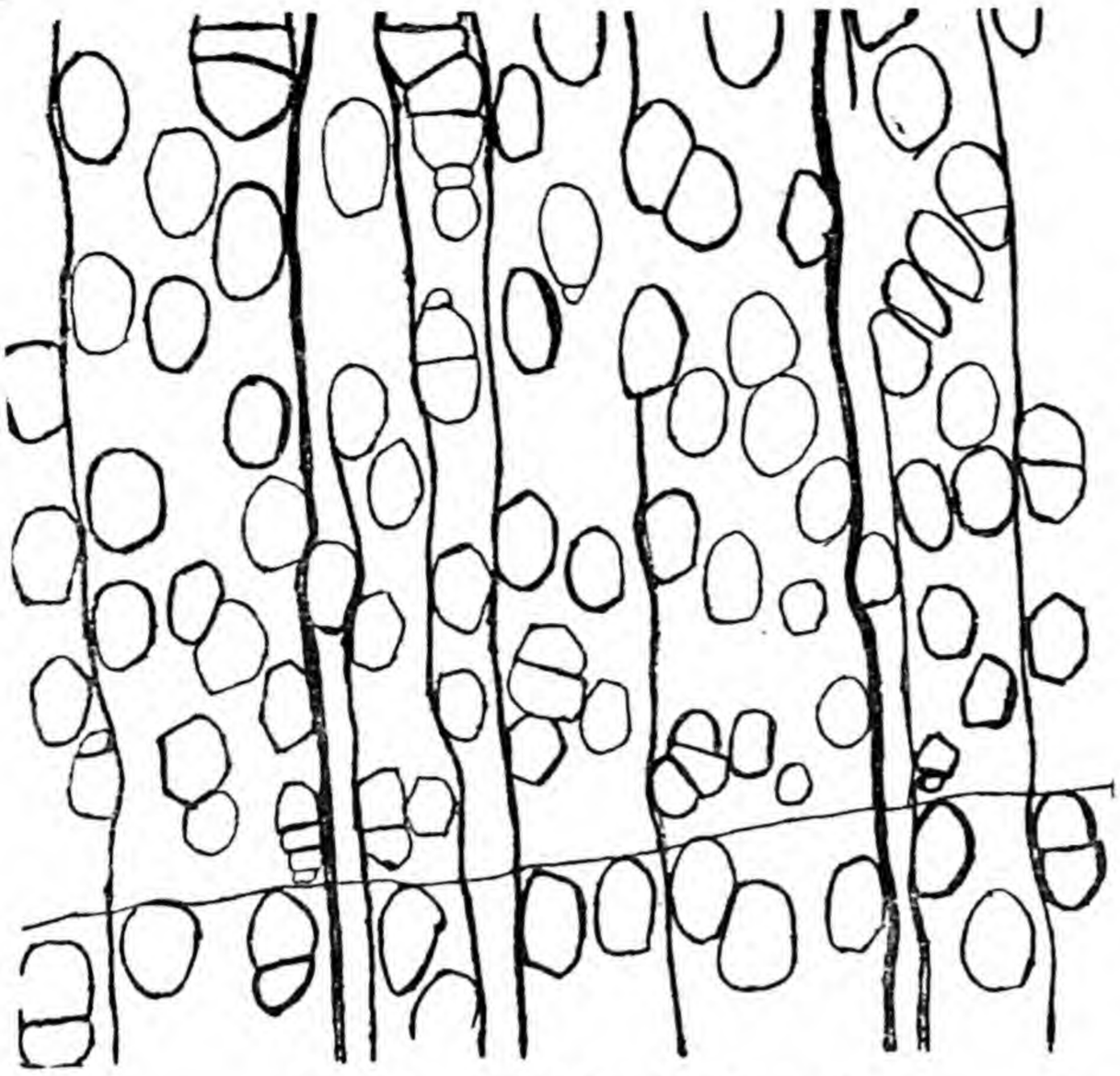

Fig. 37. WILLOW (*Salix* sp.).

Transverse Section : Diffuse-porous.

Vessels small, numerous, somewhat angular and with a tendency to form oblique lines. Often in radial groups. Little demarcation between spring and summer wood. *Rays* fine and numerous.

N.B. The transverse section of Poplar is very similar to Willow.

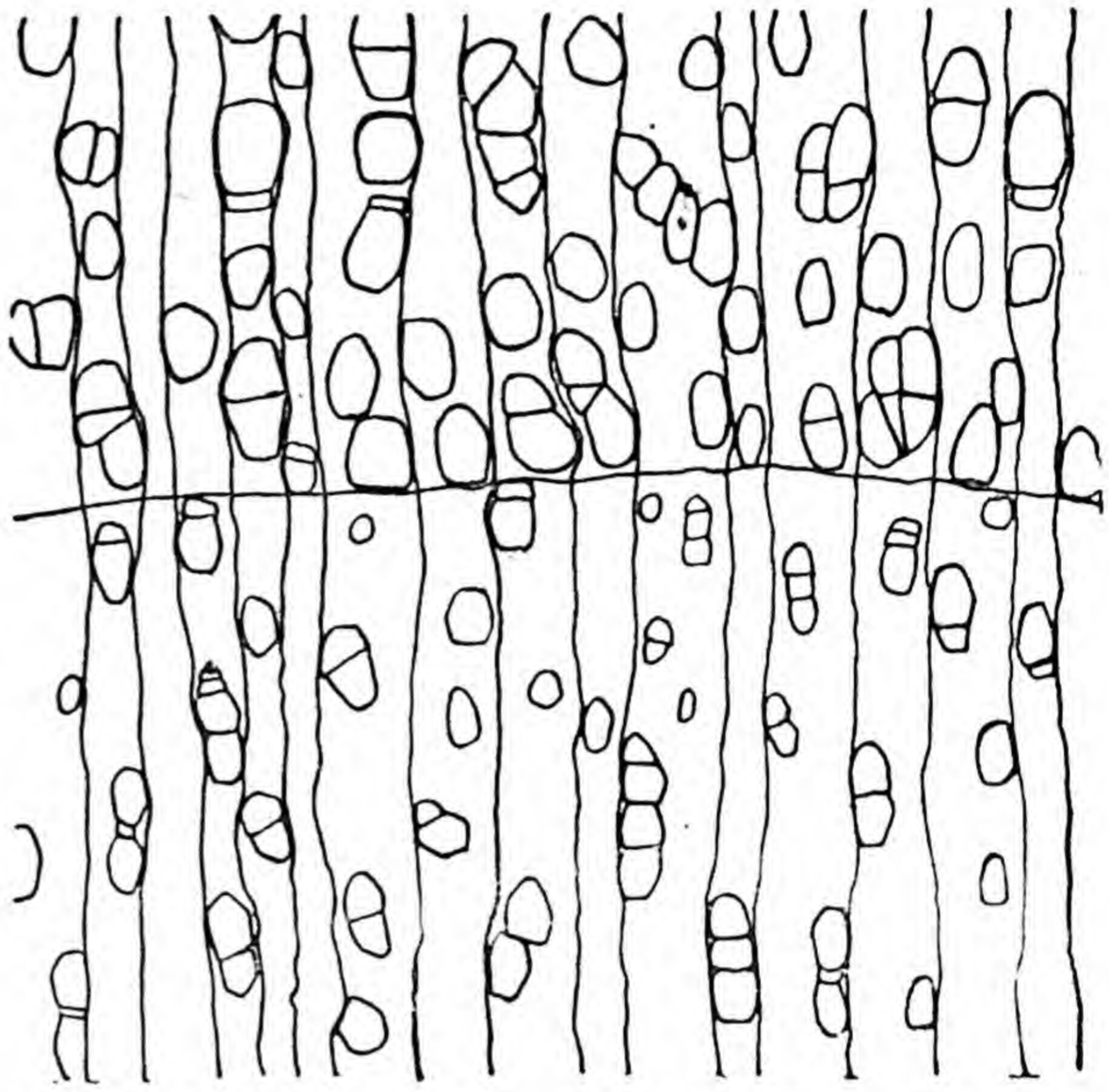

Fig. 38. HORSE CHESTNUT (*Aesculus Hippocastanum*).

Transverse Section :

Diffuse-porous wood. Little demarcation between spring and summer wood.

Vessels small, more numerous at the commencement of the season's growth. Mostly single, but also arranged in radial groups.

Rays very fine, undulating and abundant.

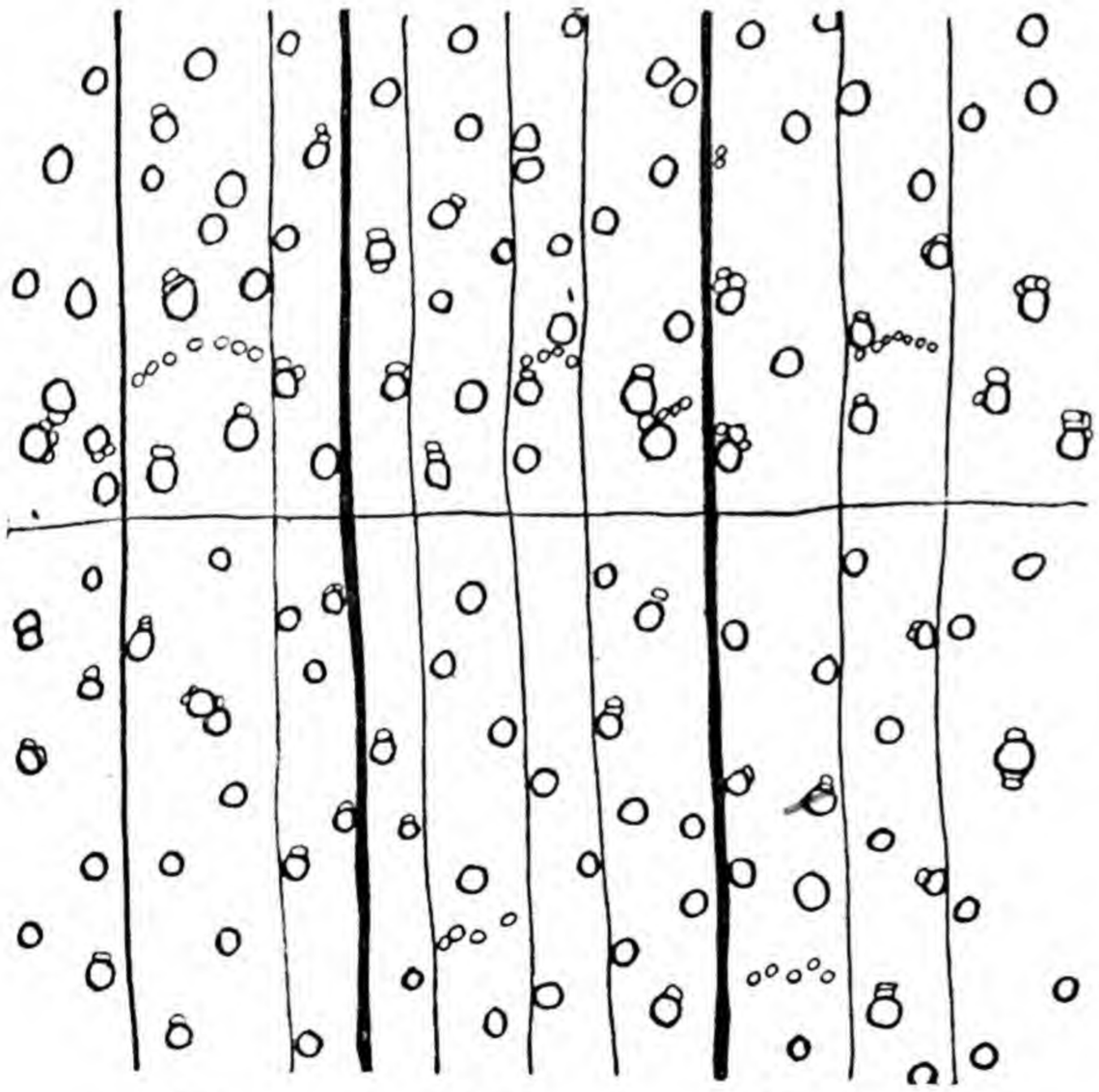

Fig. 39. BOX (*Buxus sempervirens*)

Transverse Section :

Diffuse-porous wood, little demarcation between spring and summer growth.

Vessels very small, chiefly isolated.

Rays extremely fine.

Fibres exceedingly thick-walled.

Parenchyma scattered with a tendency to be arranged in tangential lines.

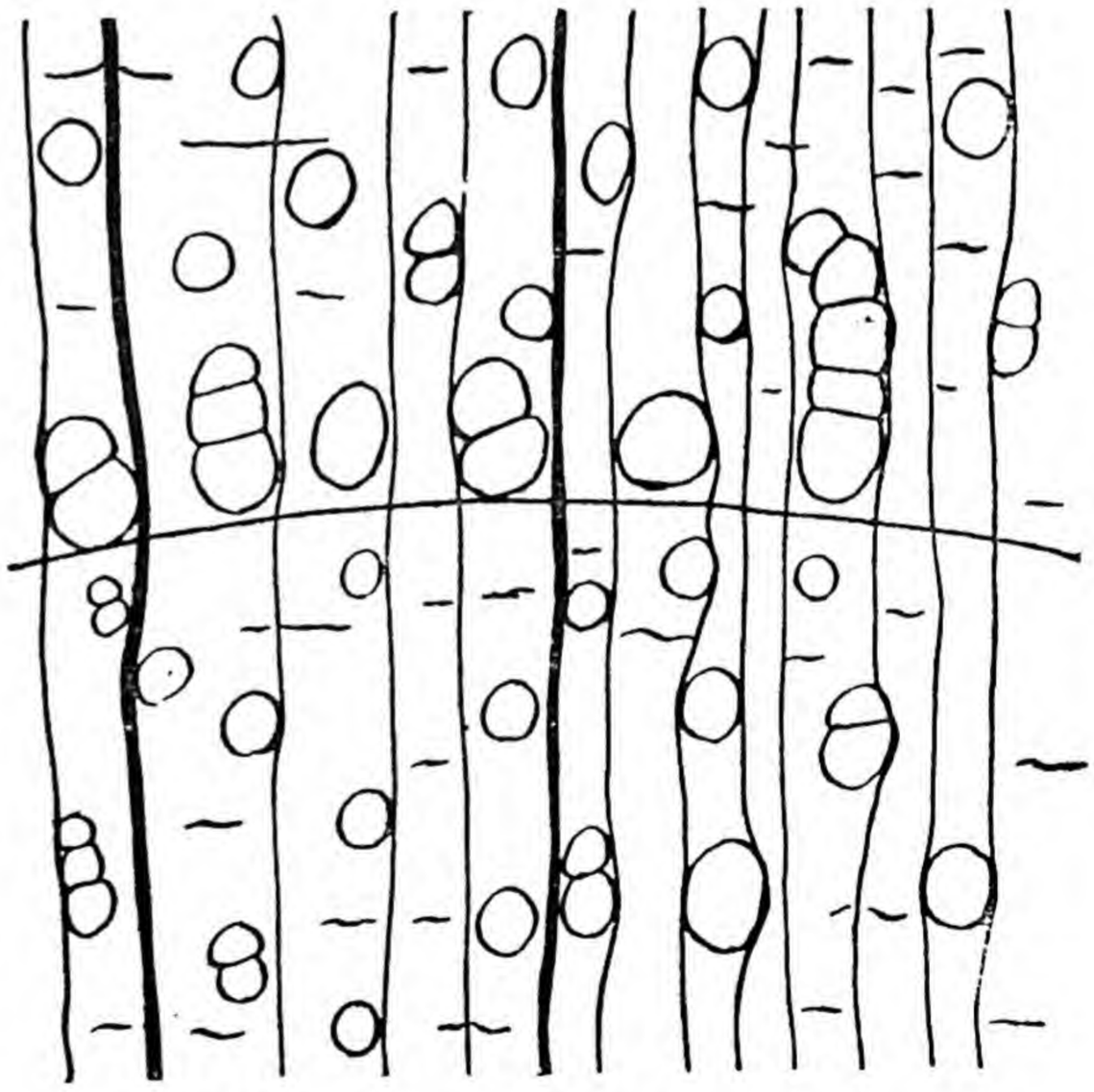

Fig. 40. WALNUT (*Juglans regia*).

Transverse Section :

Vessels in spring wood sometimes with a tendency to form a pore ring ; mostly single, but frequently arranged to form oblique lines, also sometimes in radial groups.

Rays small, fairly numerous.

Parenchyma in short tangential lines, but very difficult to see with lens.

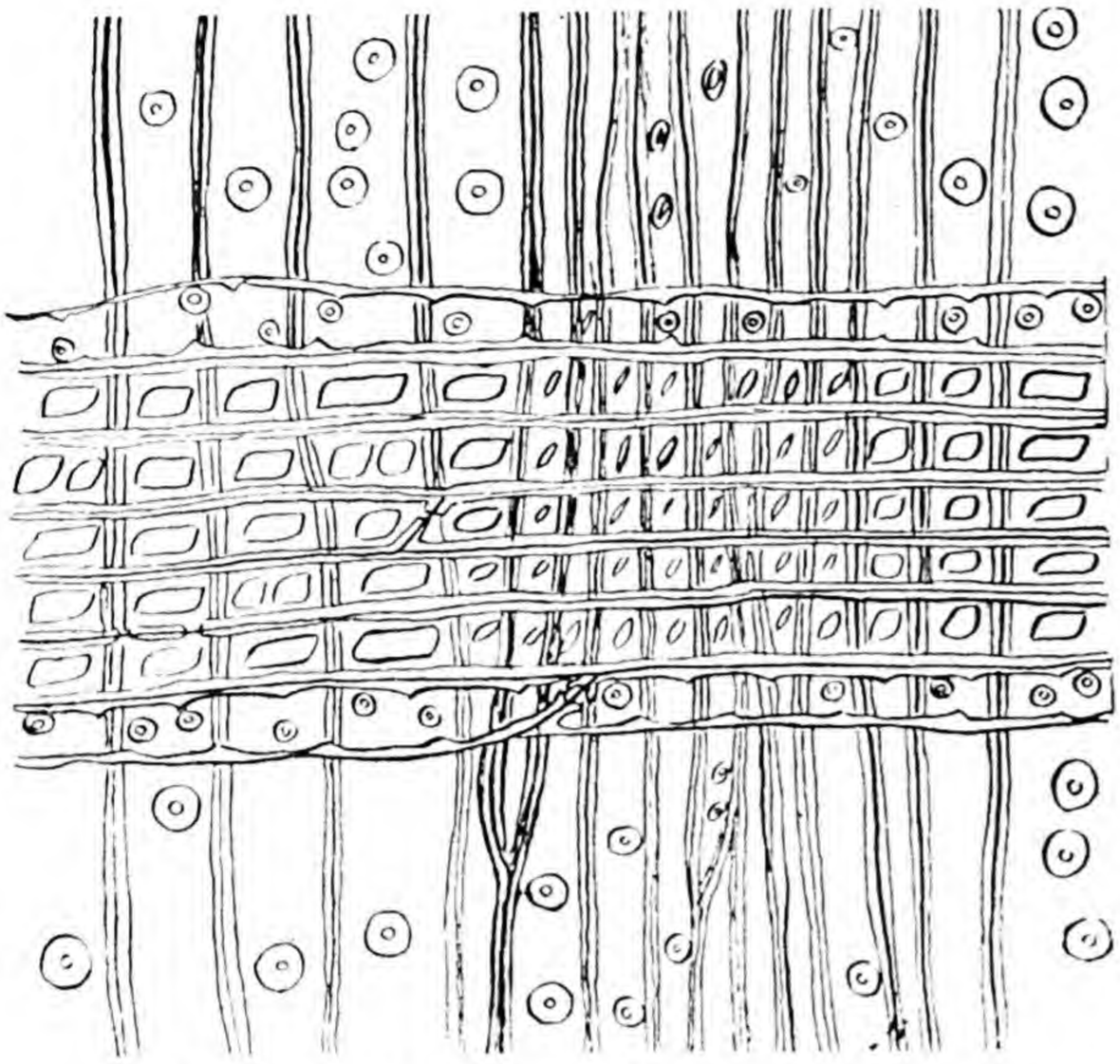

Fig. 41. SCOTS PINE (*Pinus sylvestris*).

Radial Section :

Ray tracheids present—dentate (toothed). One or two large eye-shaped simple pits connecting ray cells to each vertical tracheid.

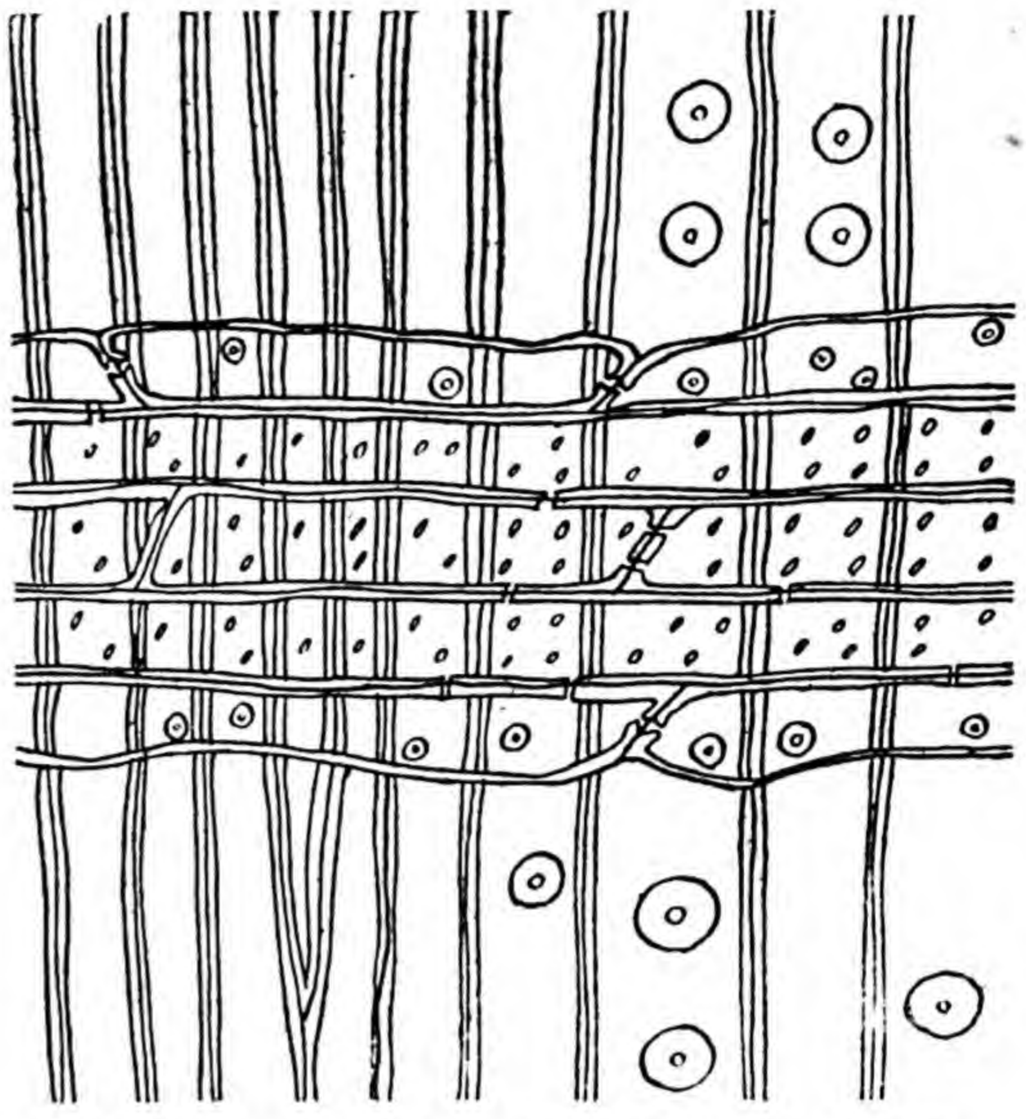

Fig. 42. COMMON SPRUCE (*Picea Abies*).

Radial Section :

Ray tracheids present, high, non-dentate. Simple pits small, slit-like, one to four or more connecting ray cells to each tracheid. Tendency for these pits to be arranged in the corners in the ray crossings.

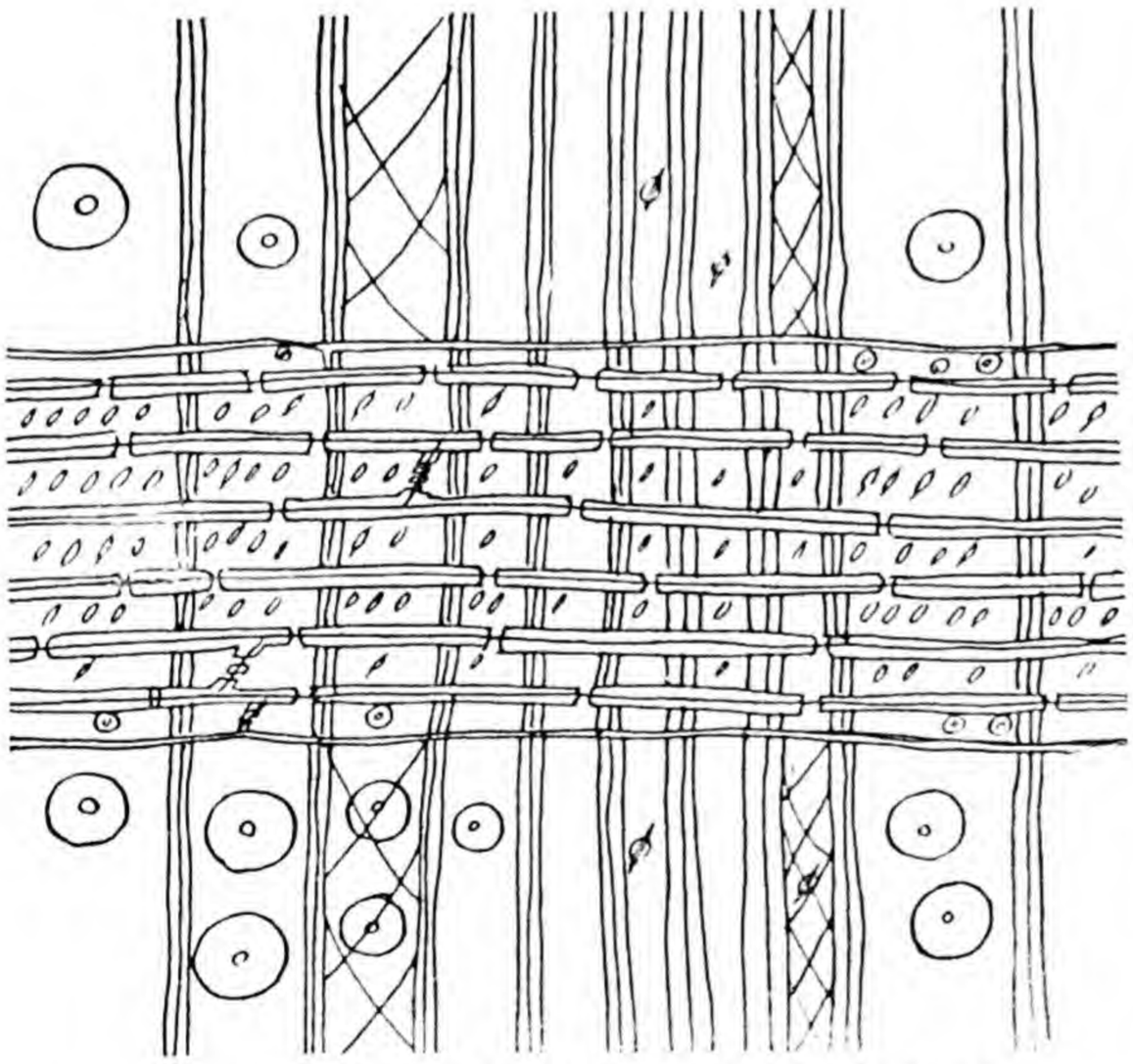

Fig. 43. EUROPEAN LARCH (*Larix decidua*).

Radial Section :

Ray tracheids low, non-dentate. Small slit-like simple pits, chiefly arranged in horizontal rows in the ray-crossings. Spiral thickening, if present, has steep pitch.

N.B. The structure of Japanese Larch is indistinguishable from that of European Larch.

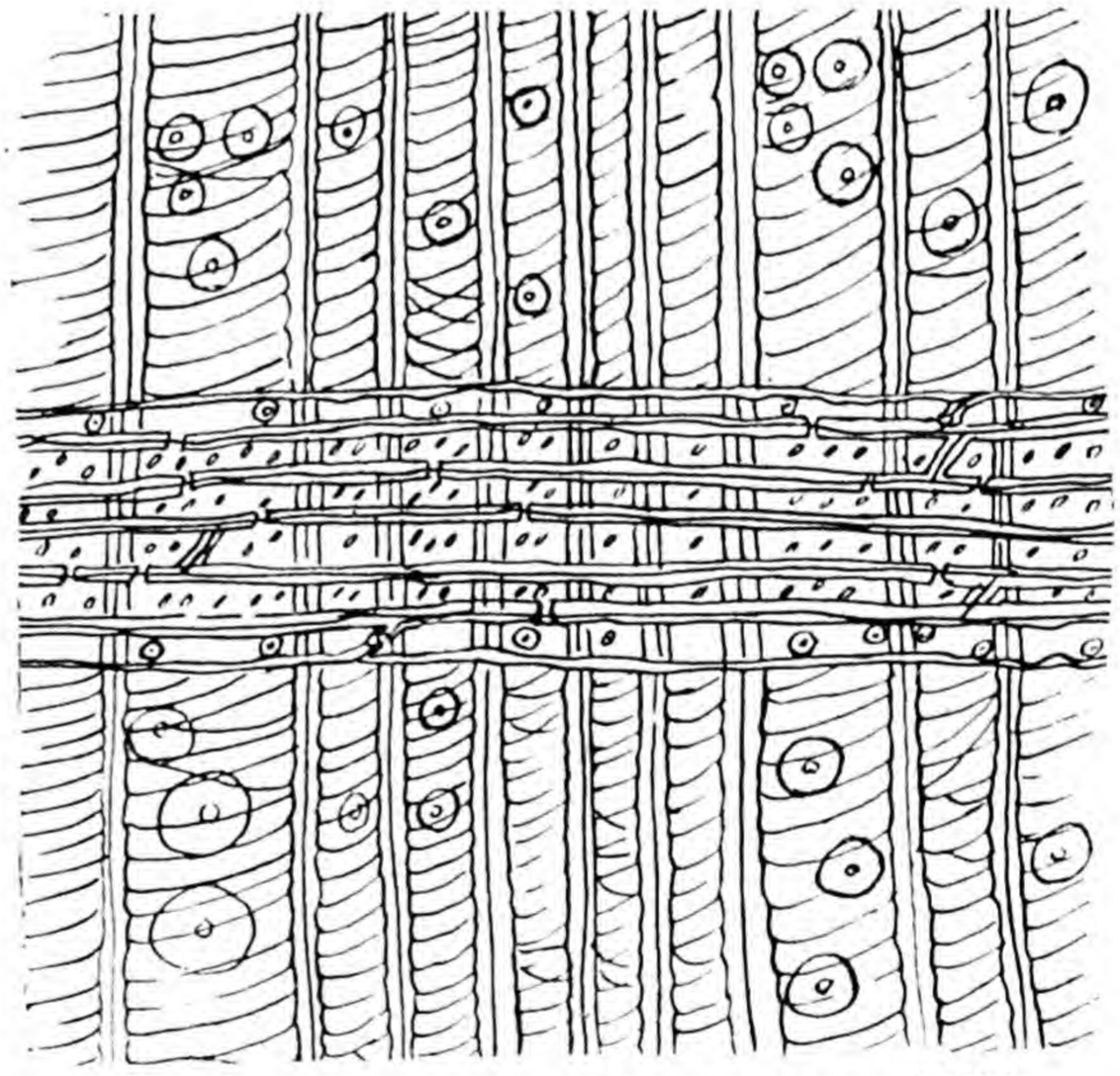

Fig. 44. DOUGLAS FIR (*Pseudotsuga taxifolia*).

Radial Section :

Ray tracheids often low, non-dentate. Simple pits small, slit-like and chiefly in horizontal rows in ray crossings. Spital thickening usually abundant, low pitched.

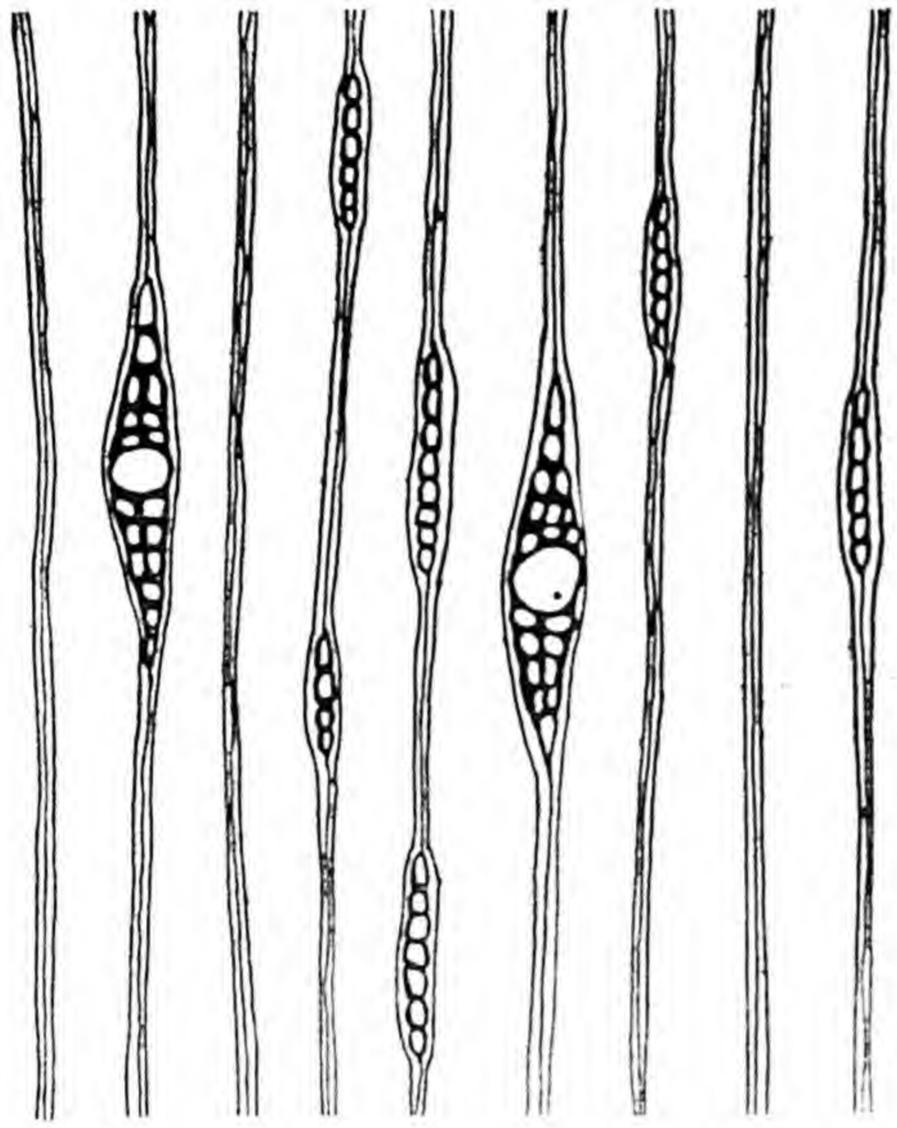

Fig. 45. SCOTS PINE (*Pinus sylvestris*).

Tangential Section :

Rays low, horizontal resin canals present, circular in shape. Rays without resin canals chiefly low and one cell wide.

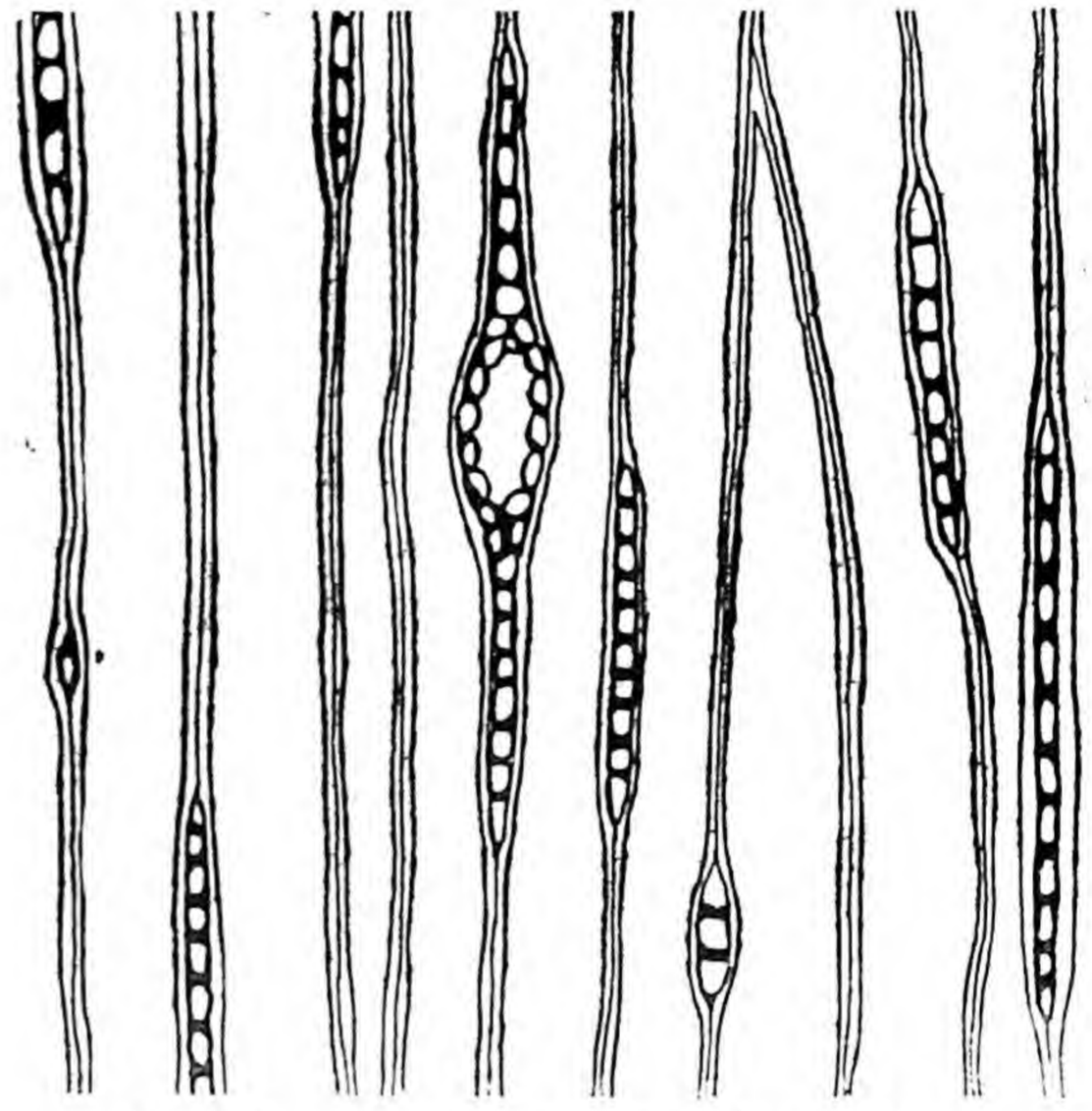

Fig. 46. COMMON SPRUCE (*Picea Abies*).

Tangential Section :

Rays high, horizontal resin canals present, oval in shape and surrounded by (usually) one layer of cells. Rays without resin canals one cell wide.

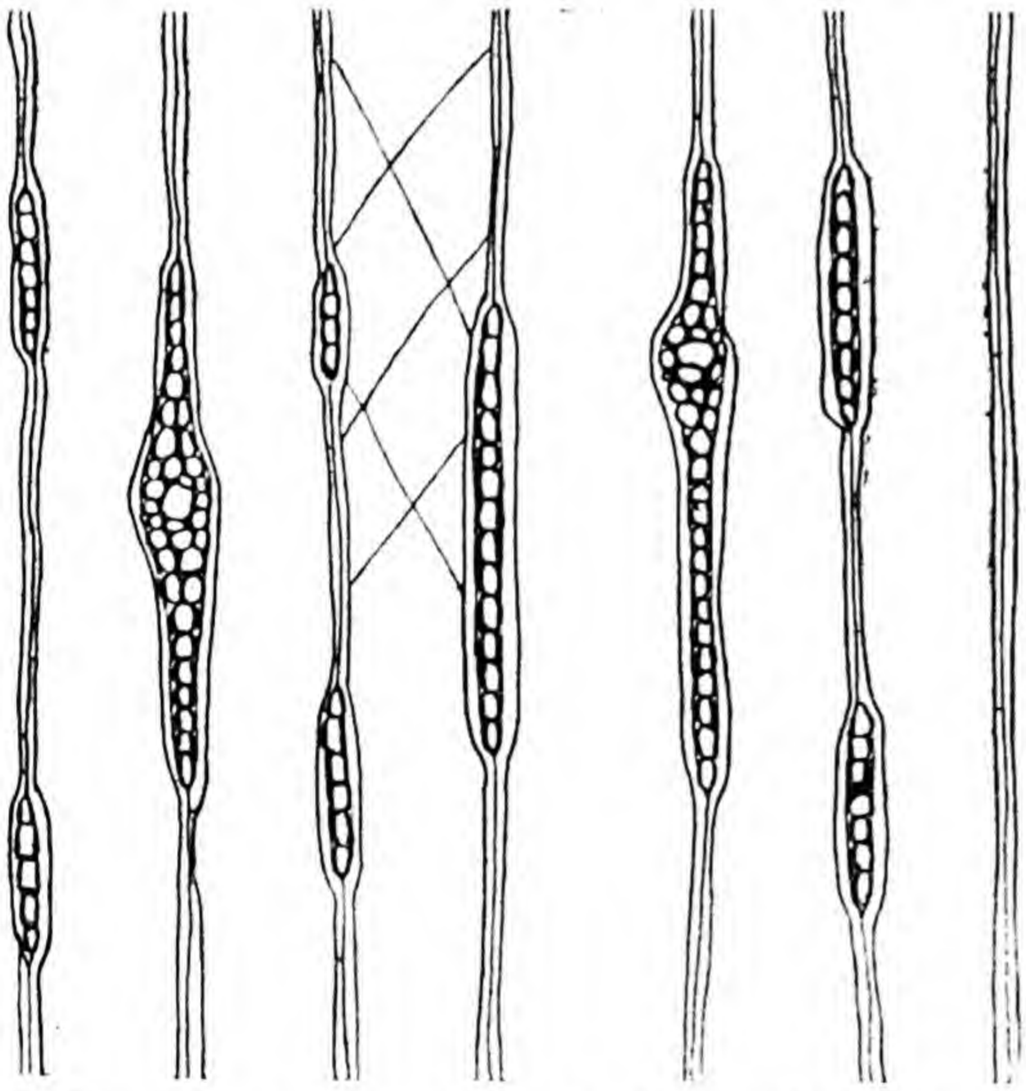

Fig. 47. EUROPEAN LARCH (*Larix decidua*).

Tangential Section :

Rays high; horizontal resin canals present, small, frequently not situated midway in the height of the rays. Spiral thickening sometimes present, with steep pitch.

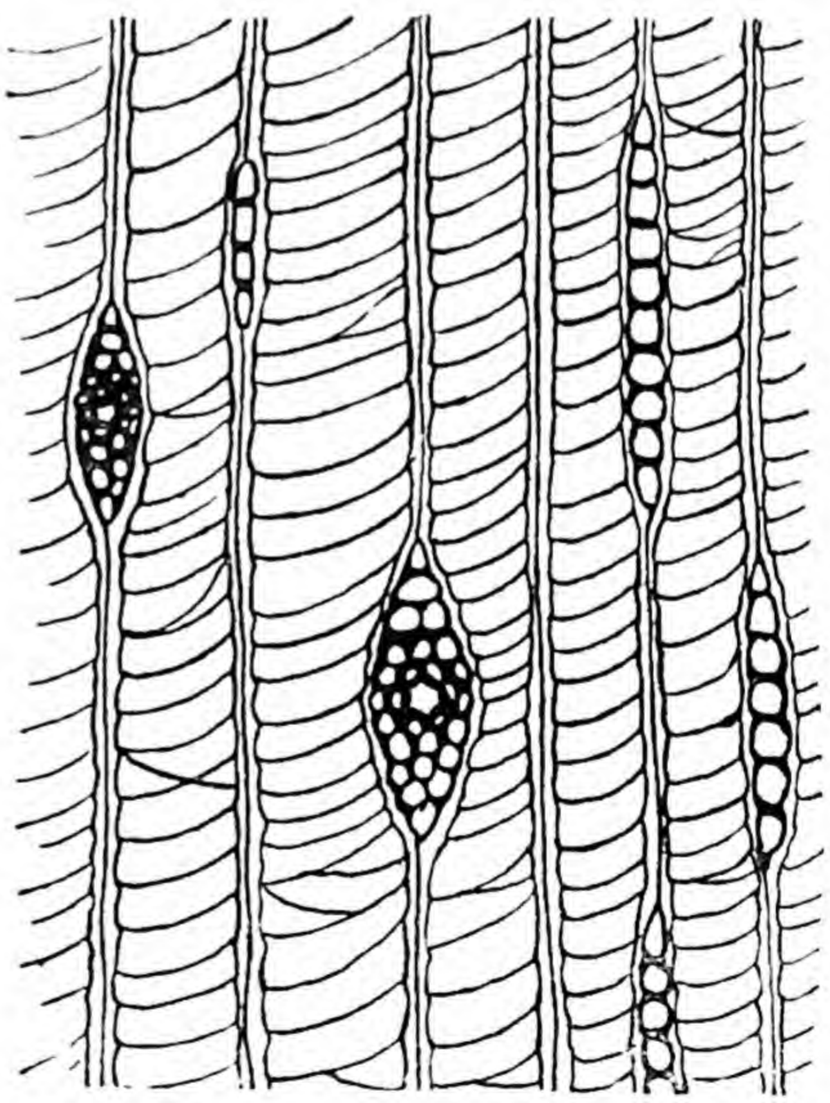

Fig. 48. DOUGLAS FIR (*Pseudotsuga taxifolia*)

Tangential Section :

Rays low, thick-walled; horizontal resin canals small, angular (usually hexagonal). Rays without resin canals one cell wide.

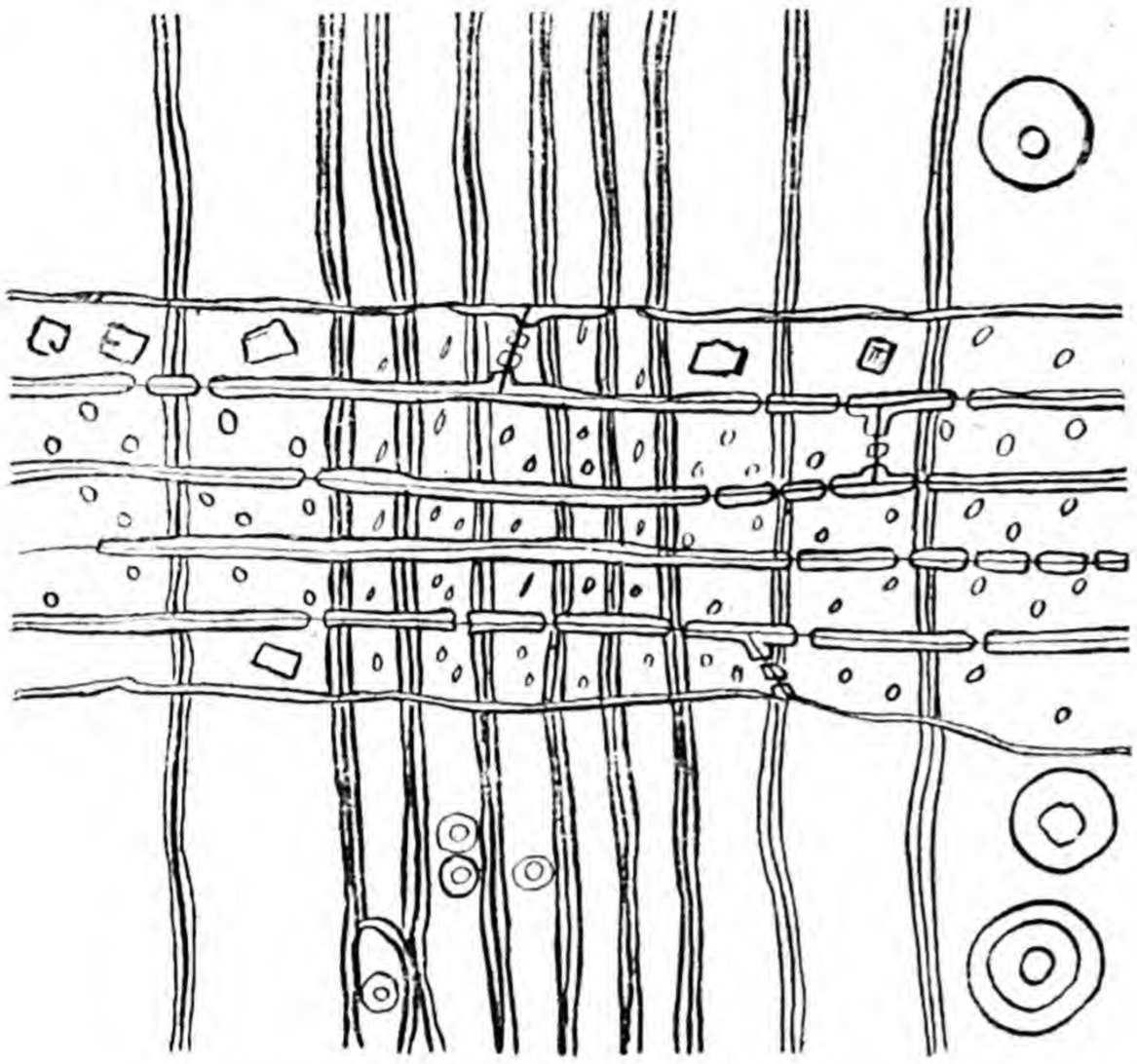

Fig. 49. SILVER FIR (*Abies alba*).

Radial Section :

No ray-tracheids ; ray marginal-cells thin-walled and frequently containing crystals. Simple pitting abundant on all ray walls ; in ray-crossings somewhat scattered, no special arrangement.

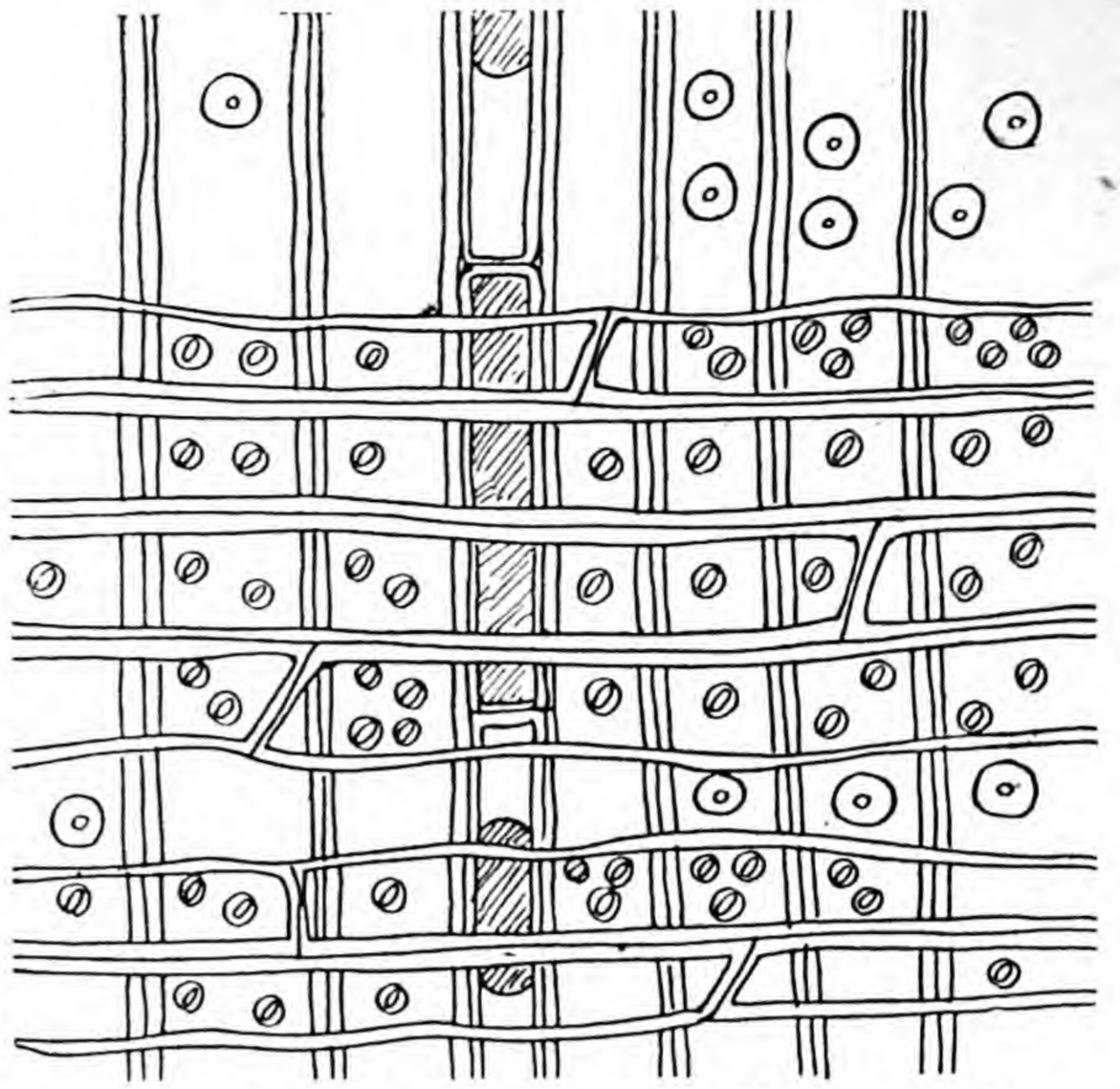

Fig. 50. LAWSON'S CYPRESS (*Chamaecyparis Lawsoniana*).

Radial Section :

Resin cells present, no ray-tracheids. Ray cells thick-walled. Pitting on transverse and tangential walls rare. Semi-bordered pits in ray-crossings prominent and with wide borders.

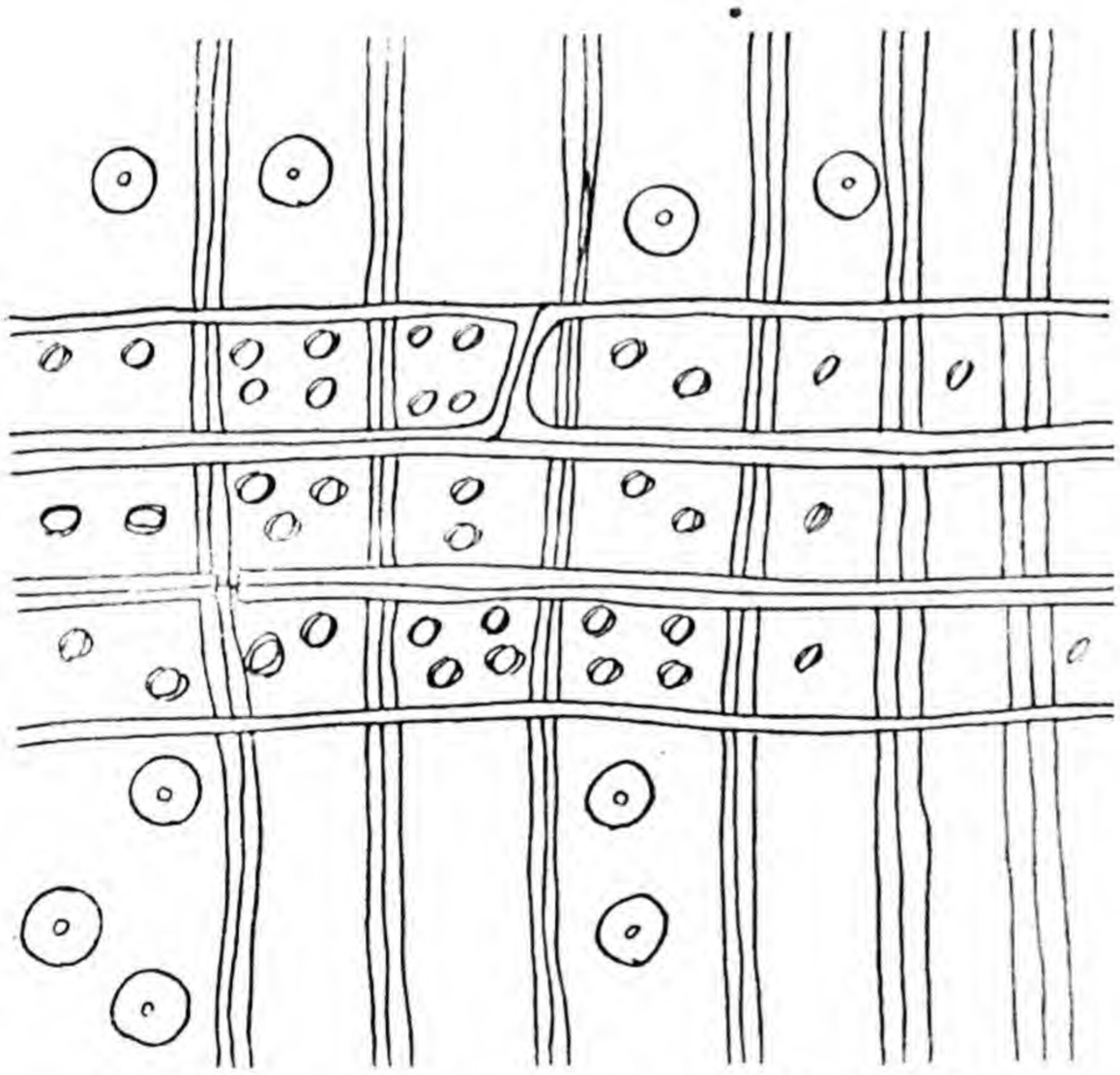

Fig. 51. WESTERN RED CEDAR (*Thuja plicata*).

Radial Section :

Resin cells few, difficult to find. No ray-tracheids. Semi-bordered pits in ray-crossings somewhat oval and with narrow borders.

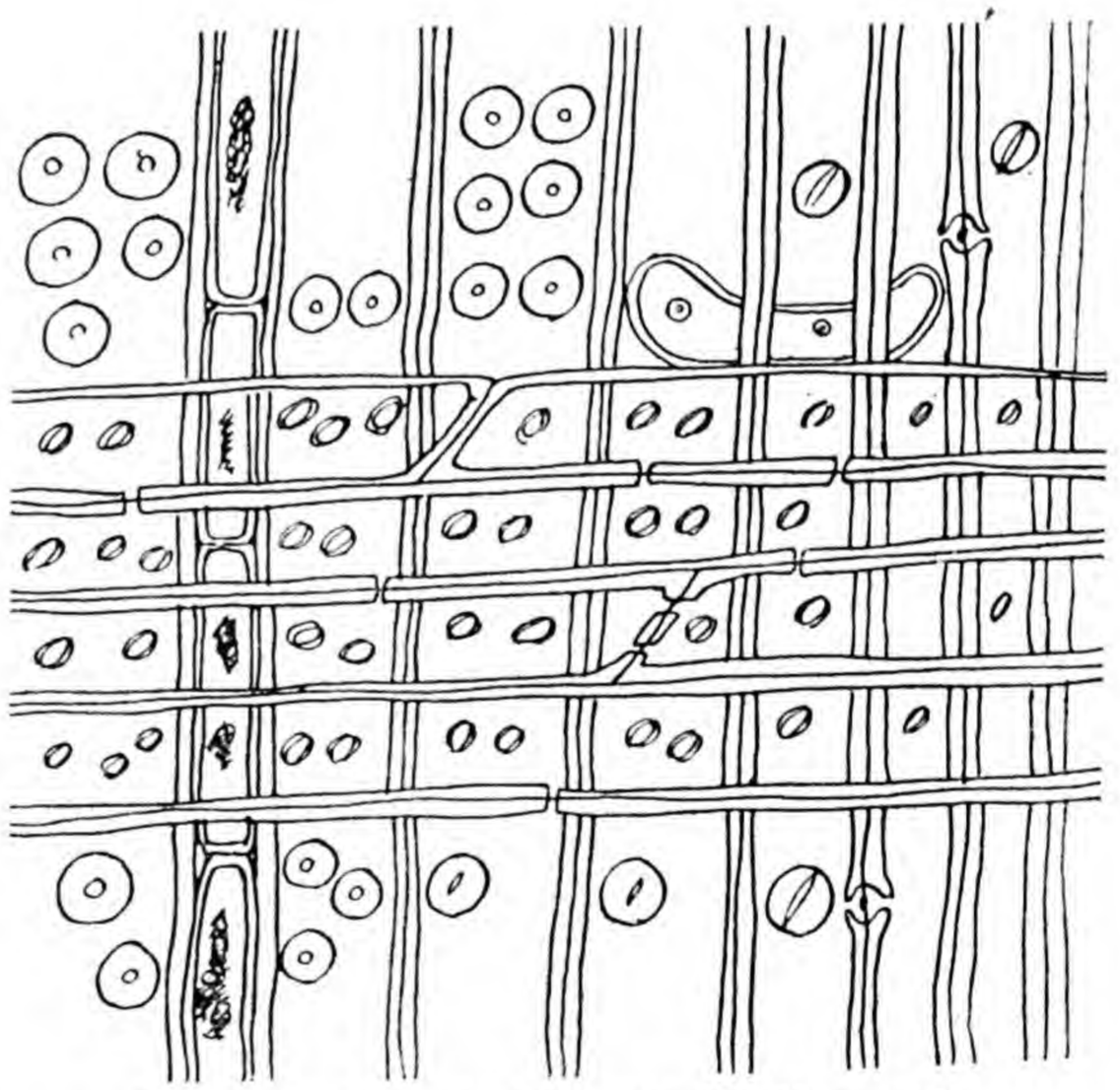

Fig. 52. SEQUOIA (*Sequoia Wellingtonia*).

Radial Section :

Resin cells present. No ray-tracheids normally present, occasionally ' ghost ' ray-tracheids occur. Semi-bordered pits in ray-crossings with a tendency to horizontal arrangement, with narrow borders.

Bordered pits in tracheids crowded, often 2 or 3 to the width a tracheid.

N.B. The structure of *Sequoia sempervirens* is identical to the above.

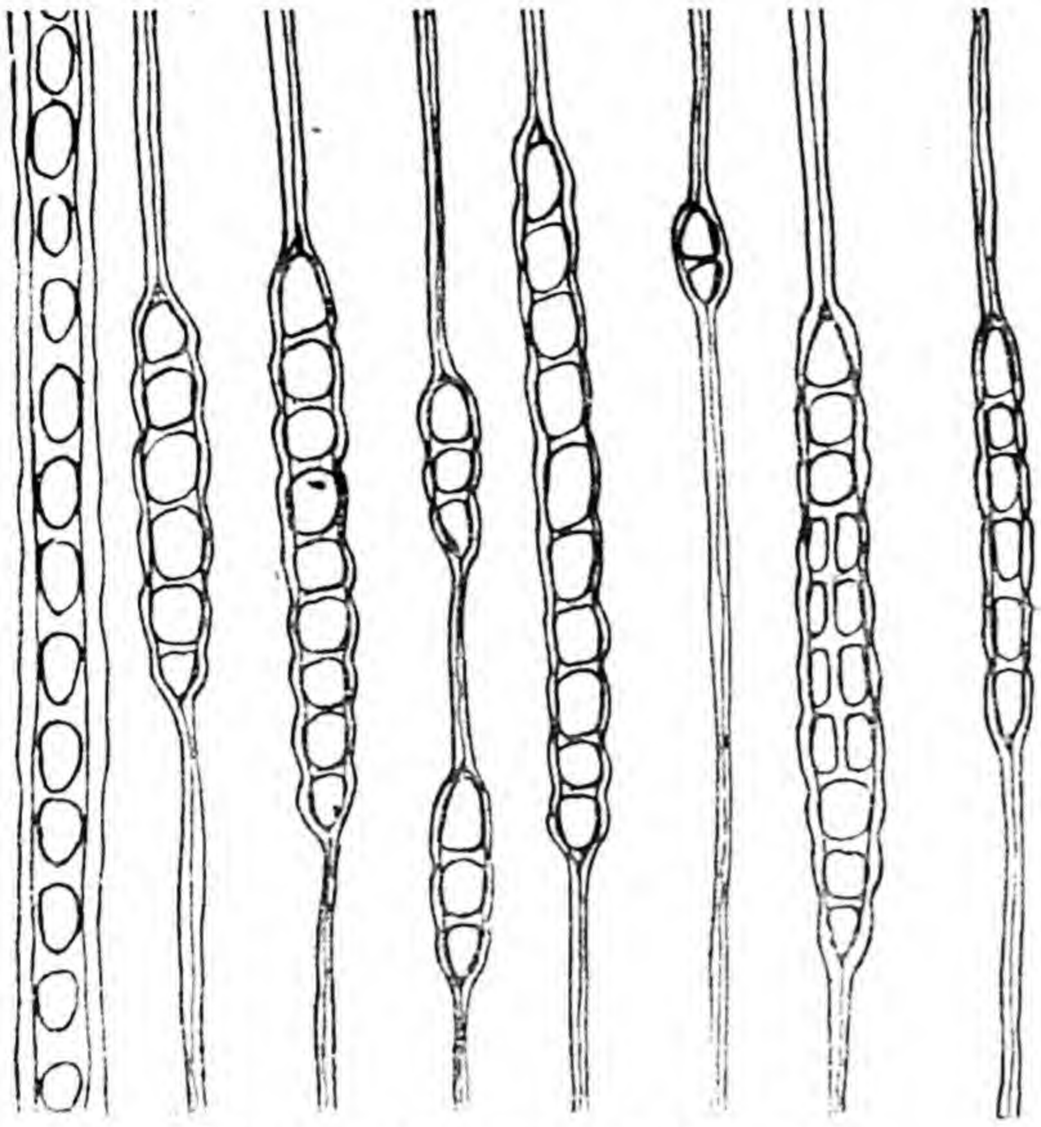

Fig. 53. SILVER FIR (*Abies alba*).

Tangential Section :

Rays frequently high, sometimes 2 cells wide.

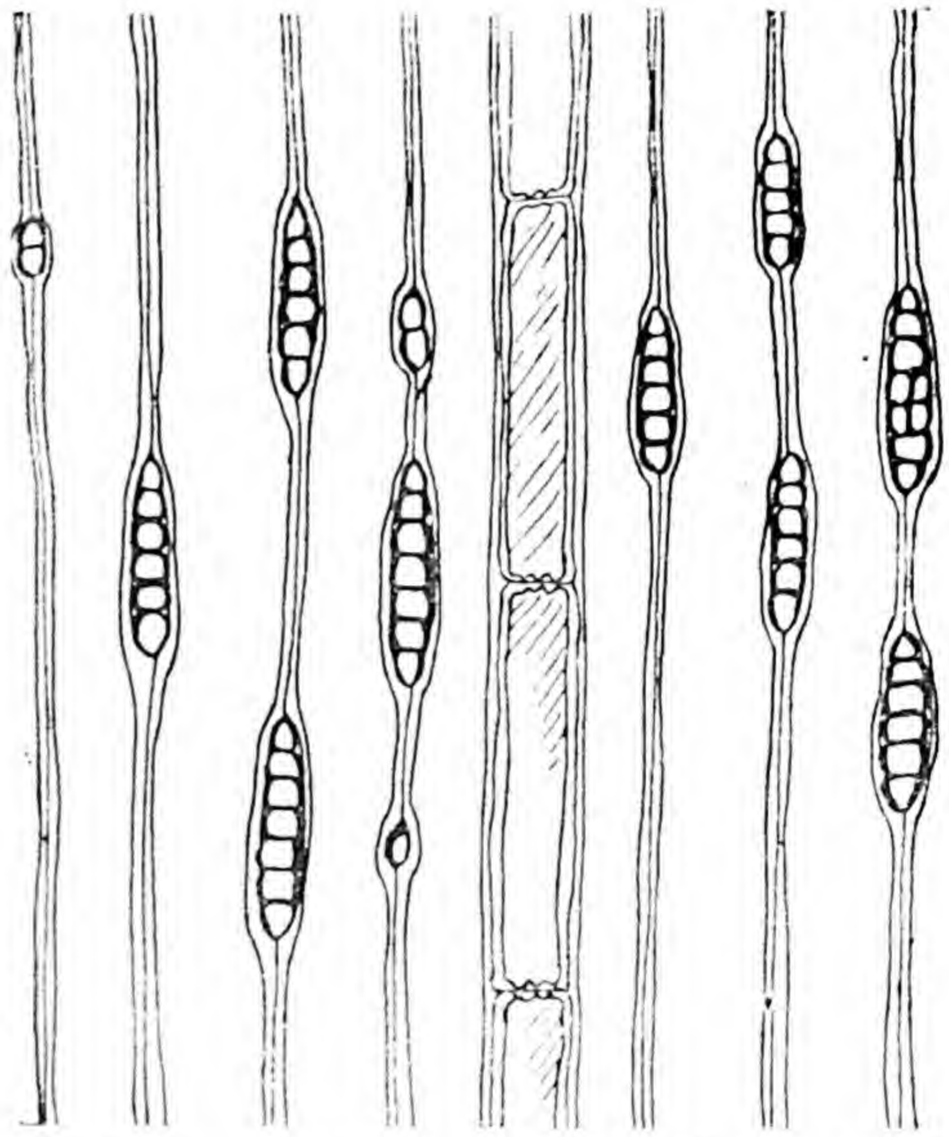

Fig. 54. LAWSON'S CYPRESS (*Chamaecyparis Lawsoniana*).

Tangential Section :

Resin cells frequently visible. Rays low, 1 to a few cells high, occasionally 2 cells wide. Ray cells often having greater width than height.

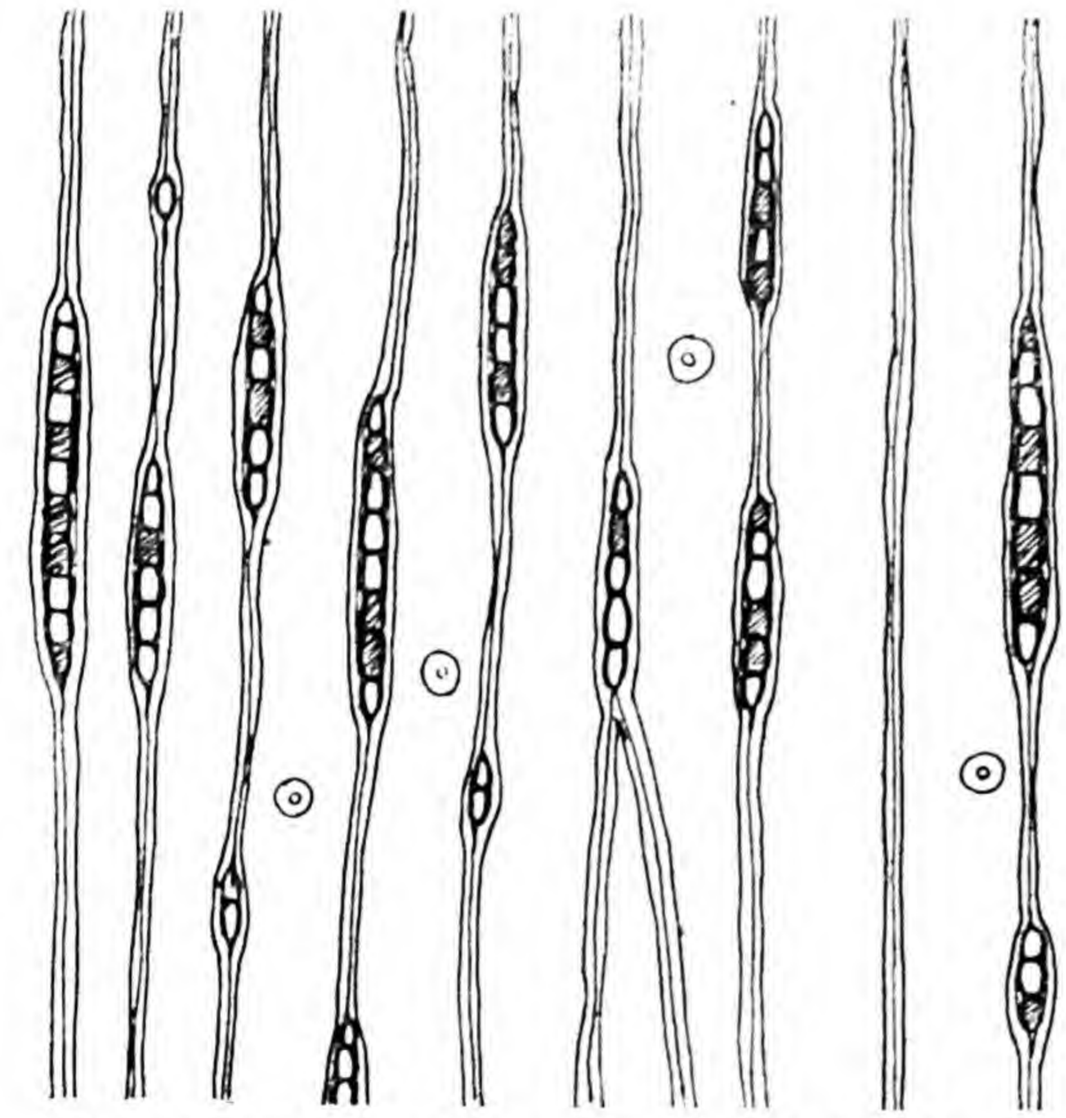

Fig. 55. WESTERN RED CEDAR (*Thuja plicata*).

Tangential Section :

Resin cells rare. Rays higher than *Chamaecyparis* and frequently charged with resin. Ray cells usually greater height than width. Small bordered pits on tracheid walls sometimes present in latter part of the season's growth.

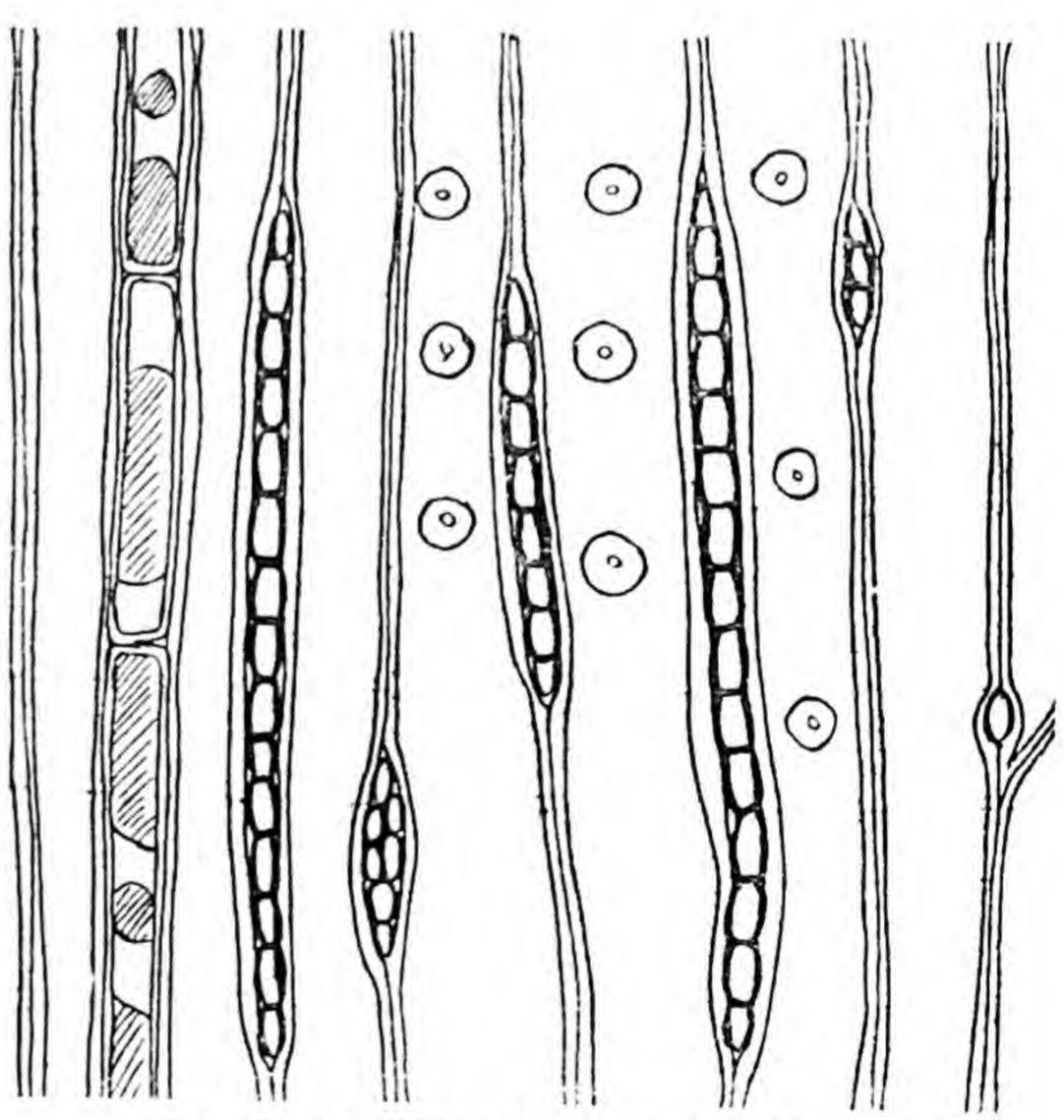

Fig. 56. SEQUOIA (*Sequoia Wellingtonia*).

Tangential Section :

Resin cells frequently visible in the latter part of the season's growth. Rays from low to rather high, sometimes 2 cells wide. Bordered pits in tangential walls of tracheids common.

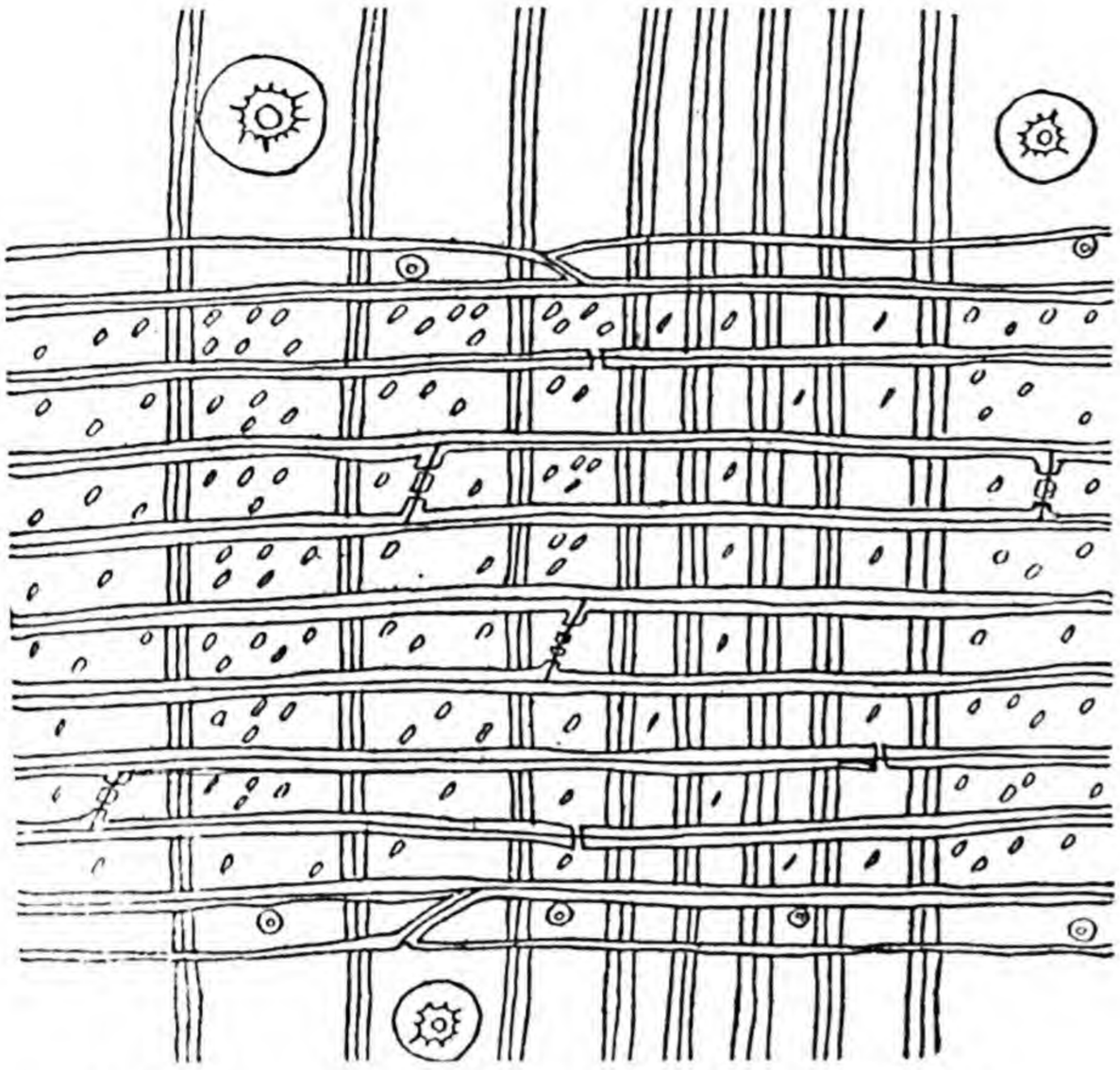

Fig. 57. CEDAR OF LEBANON (*Cedrus libani*).

Radial Section :

Ray tracheids present, non-dentate. Simple, small, numerous pits in no special arrangement in ray-crossings. Bordered pits on tracheid walls, scalloped.

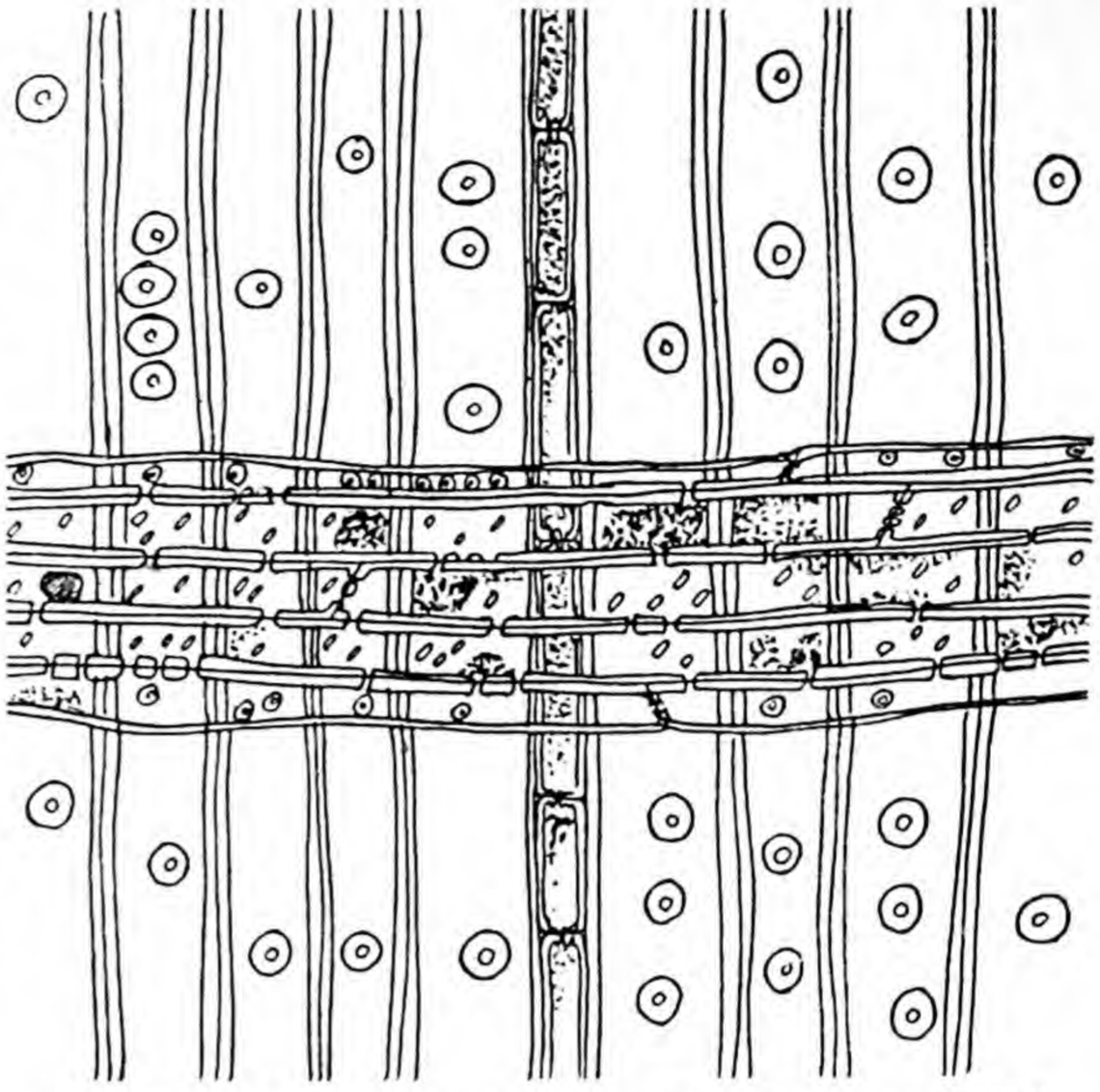

Fig. 58. WESTERN HEMLOCK (*Tsuga heterophylla*).

Radial Section :

Ray tracheids very low with very small, numerous bordered pits. Numerous, small simple pits in ray-crossings, difficult to distinguish owing to the abundance of resin.

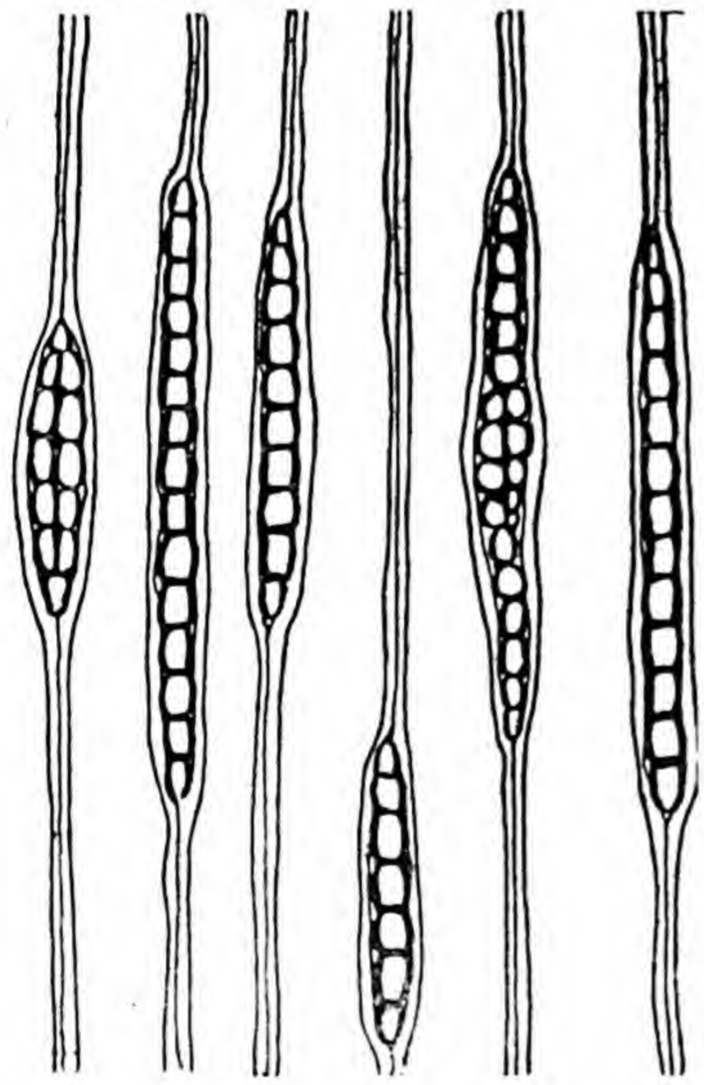

Fig. 59. CEDAR OF LEBANON (*Cedrus libani*).

Tangential Section :

Rays prominent and very high; sometimes two cells wide.

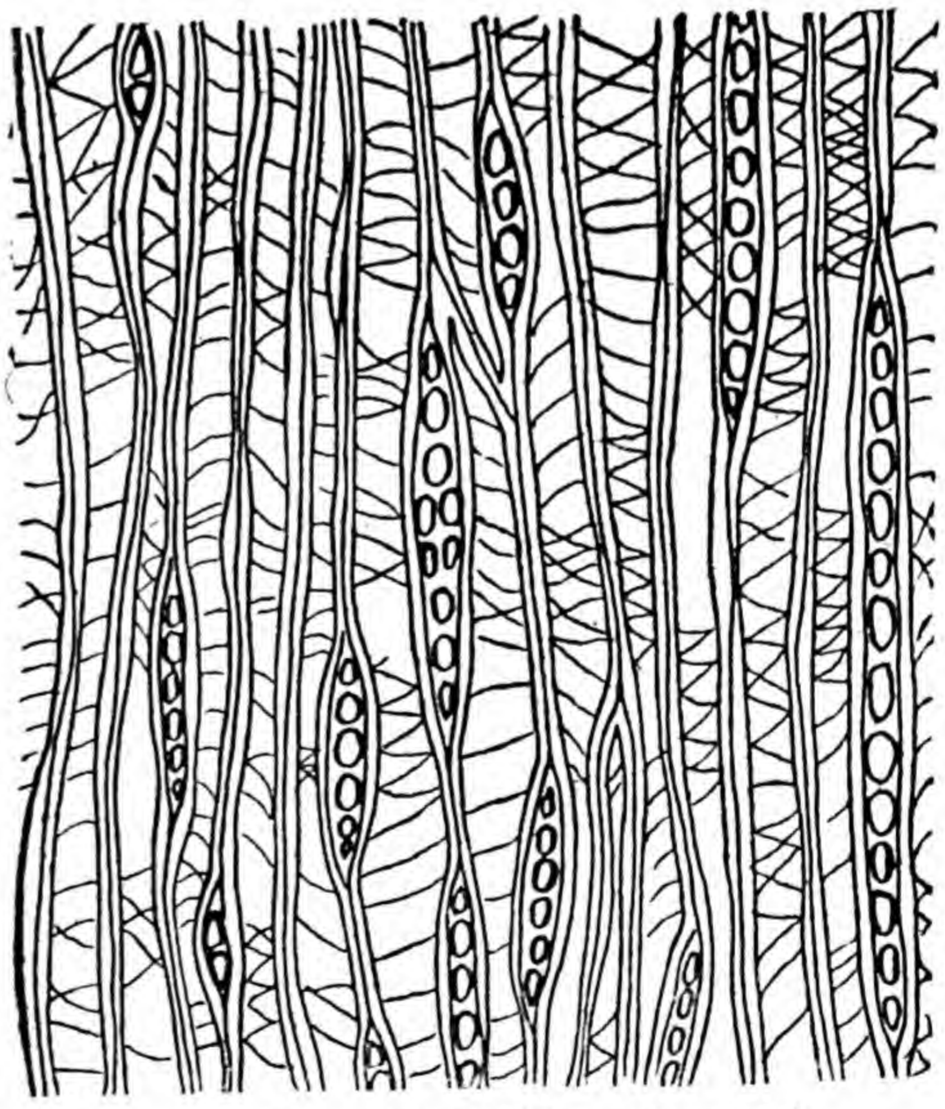

Fig. 60. YEW (*Taxus baccata*).

Tangential Section :

Rays prominent. One, sometimes two cells wide. Ray cells thick-walled. Spiral thickening abundant.

CHAPTER V

PRINCIPAL HARDWOODS

ALDER

BOTANICAL NAME : *Alnus glutinosa* Gaertn.

FAMILY : *Betulaceae*. Other members of this family include the genera *Betula*, *Carpinus* and *Corylus*.

COMMON NAMES : Black Alder, Howler, Owler and Aller. These names are sometimes used by country people.

DISTRIBUTION. Alder has a wide distribution in temperate Europe, West Asia and North Africa ; it is found as far east as Japan. In West Russia there are vast alder marshes, where alder is the predominating tree. It is one of the few trees indigenous to Britain.

THE TREE. Usually a small tree 30 to 40 ft. in height, and 1 to 2 ft. in diameter. Under good conditions, however, it may reach 90 ft. or even 100 ft. with a diameter of 4 ft. ; a clear bole of 25 ft. is not uncommon but is rarely exceeded. On a porous soil alder assumes a bush-like form. The tree is abundant by riversides and on low-lying, moist land, and may be found as far north as Caithness.

Soil and Situation. The best soil is a moist loam, preferably with a good humus (formed by litter washed down by rain from forests at higher elevations, for instance). It is accommodating, however, and will grow on most soils that are not porous, provided sufficient moisture is present. As alder roots have nodules containing bacteria, which convert atmospheric nitrogen to soluble nitrogenous salts, the tree improves the soil. Alder will also help to drain the soil and dry out the land.

In undrained, boggy places alder is the only tree which will grow, willow needs rather fresher soil.

Sylvicultural Characteristics. Although there is no tap root, alder is fairly wind-firm ; it is somewhat tender to late frosts, but more damage is done by floods when the tree is flushing in spring.

Alder thrives best with full overhead light, but it will endure some shade as when it is coppiced and grown under standards of oak or ash. This latter method of treating alder is no longer economic, and alder coppice should be " stored," *i.e.*, all shoots cut back except one, which is allowed to grow on and form a tree. A rotation of 60–80 years is suitable.

Cultivation. Seedlings are the best method of propagation. Seed is first produced when the tree is about 20 years old and subsequently almost every year. Seed beds are greatly improved by the addition of soil from old alder beds (because of the bacteria in such soil).

THE TIMBER. When in the growing tree, or immediately after felling, the timber is white, but it very quickly changes to a reddish or orange-brown colour and then to a pale, pinkish brown. There is no obvious distinction between heartwood and sapwood. The timber is characterised by the presence of short dark lines scattered irregularly over the longitudinal surfaces, a double silver grain is seen on the quarter-sawn surface, caused by the combined large and small rays (see p. 27 for anatomy).

Occasionally highly figured logs of alder are obtained, the figure consisting of a mass of dark, twisted lines which are commonly known as ' pith flecks '. The lines are caused by the grubs of a fly (*Agromyza carbonaria*) boring just below the bark (in the cambium) in the living tree. This figuring is more often found in alder imported from Central Europe than in British-grown timber.

Alder is a fairly light wood, weighing about 33 lbs. a cu. ft. when seasoned. It is somewhat soft, usually straight grained, and has a fine uniform texture and a dull, lustreless though resilient surface (so that a light blow will cause a depression which ultimately recovers and fills out). It is a very poor conductor of heat, and so is known as a warm wood, for this reason it is the most popular wood for clogs.

DURABILITY. It is not resistant to decay under normal conditions, but under water will last indefinitely, and this is one of the reasons it is a popular wood for piles, sluice gates, etc. It can easily be impregnated with preservatives should the timber be required to be used in the open.

It is prone to attack by furniture beetle, damage from which is often found in imported alder plywood. It is never attacked by the Lyctus beetle. Alder has very low fire-resistance properties, igniting easily and burning quickly.

SEASONING. Alder air-seasons well and kiln-seasons without trouble or undue degrade, and fairly rapidly. (Kiln Schedule II probably suitable.)

STRENGTH. The timber is soft and not very strong, being in fact one of the weakest of British hardwoods. Its resilient surface, how-

ever, makes it of value for such purposes as textile rollers, etc.

WORKABILITY. The timber offers no difficulty in breaking down on the saw. It works easily with all hand and machine tools, but sharp and thin-edged tools should be used in order to obtain a smooth finish, owing to the softness of the wood which will otherwise tend to tear up, especially logs having curly grain. It veneers excellently and takes glue well, and so is a good timber for plywood; holds nails well and is quite a good turnery and carving wood. It also stains well, and takes a good finish, and may be painted.

Size and Availability. Practically all logs of alder converted in this country are home-grown, but the vast quantities of alder plywood which were used before the war were all of foreign growth, being imported from Scandinavia, Russia and Central Europe.

Home-grown logs are seldom more than 20 ft. long (average 10 ft.) and will yield boards up to 12 ins. wide (average 6 ins.). There is not an abundant supply of logs, as much of the alder is either small, deformed, branchy or bush-like. There is, however, generally sufficient to meet the somewhat limited demand.

USES. Home-grown alder is chiefly used for the following purposes:

Clogs (alders are often bought standing by men who fell and roughly shape the clogs on the site. Unfortunately the supply of alder near industrial towns is very limited, and birch is often used in its place), artificial limbs, soles of shoes, toys, cheaper cabinet work, sluice gates, piles for supporting river banks (owing to its durability under water: in this connection it is stated that many of the piles on which Venice stands are of alder). The softness, lightness and ease of working makes alder ideally suited for artificial limbs, turnery, especially textile rollers, hat blocks, etc.

In the past alder was the chief wood for charcoal, for use in the manufacture of gunpowder: very little is used for this purpose now. On the Continent the wood is often used for cigar boxes.

Occasionally highly figured timber is obtained and this is used for cabinet work, especially small decorative boxes, etc. Such figured timber is usually derived from burrs, abnormal butts and stems attacked by insects, as described under the paragraph 'Timber'.

GREY ALDER

(*Alnus incana* Moench)

The grey alder (sometimes called "white alder") is not native of Britain, having been introduced in 1780. It is widely distributed in Europe and parts of Asia, and is found in Eastern N. America.

THE TREE. It is fairly common in Britain and grows to a somewhat larger size than the common aldér; it is also more hardy and is well adapted for planting in cold, wet situations. On the other hand, it will succeed on dry soil and will also endure a considerable degree of shade.

TIMBER. The timber is identical to that of the common alder and can be used for similar purposes.

RED ALDER OR OREGON ALDER

(*Alnus rubra* Bongard)

This species is occasionally grown in Britain, but is rare. It is, however, the most important species of alder in N. America, and is mainly found in the West Coast States of Oregon and Washington, also in British Columbia and as far south as California.

It is used both in plywood and extensively for furniture, also for carving, various types of containers, toys, etc. It is occasionally bleached and sold as basswood (*Tilia americana* L.).

ASH

BOTANICAL NAME: *Fraxinus excelsior* L.

FAMILY: *Oleaceae*. This family includes the Lilac (*Syringa*), Privet (*Ligustrum*) and Olive (*Olea*). There are about 40 species of ash, most of which are native to North America, but several are found in Europe.

COMMON NAMES: English Ash, European Ash.

DISTRIBUTION. Ash is widely distributed in Europe and is native to England. It is found as far east as the Crimea, and its southern limit is from Asia Minor to Turkey and Italy, Southern France to Portugal.

THE TREE. Ash is one of the largest European deciduous trees, and in this country it attains a height of 100 ft., occasionally reaching 140 ft. and a diameter of 3 ft., or occasionally up to 5 ft.; it is, however, usually not more than 2 or 2½ ft. in diameter. Except when grown in woods and surrounded by other trees the length of clean bole is seldom more than 30 ft., after which the enormous crown may extend 50 ft. or more upwards. Specimens are, however, known having a bole of 50 ft. clear of branches.

A characteristic of ash is the frequency of forked growth. The trunk will often be found to fork fairly low down and the individual branches also fork. This is caused by the leading buds being killed either by insects, especially the

ash bud moth (*Prays curtisellus*), or by frost. The two lateral buds flanking the leading bud usually escape damage as they open somewhat later. The tree comes into leaf later than almost any other British tree, *i.e.*, about the end of May, and is the first to lose its foliage in the autumn.

Ash is a very common tree in Britain, and frequently seen in hedgerows, but it is possibly the worst tree to plant in hedgerows bordering agricultural land, as it is an extremely heavy feeder and its network of shallow surface roots impoverishes the ground for a considerable distance from the tree.

Soil and Situation. In all respects ash is a hardy tree, and accommodating as to soil and situation. It will succeed on most soils that are not too high lying or exposed, but thrives best on a fresh, deep, light loam, especially limestone soil, and preferably one which has an admixture of humus and is over 3 ft. deep. Very dry sandy porous soils are the least suitable, and heavy clay soils must be well drained. The ideal site is in valley bottoms or on the side of ravines. It generally prefers a northern aspect.

Sylvicultural Characteristics. Ash is wind firm, but it is inadvisable to plant it on exposed sites because the wood tends to become short grained, owing to the constant wind stresses.

When young the tree will endure a certain amount of shade, more, for instance, than oak, but later it is emphatic in its demands for light and will not tolerate any overhead shade. It is tender to late frosts, especially in low-lying situations, but the lateness of its flushing renders this point not so important. The fastest growth in height takes place between 20 and 40 years old and the greatest girth increment occurs in the next 20 years. Ash is not a very long-lived tree, and it is mature at about 60 years. There are examples of trees 300 years old, but these are probably defective in the heart (' black-hearted ' or rotted), and, in any event, the timber is not of the best quality. A common method of growing ash in Denmark is to grow it in orchards and prune each tree.

Cultivation. Ash is best propagated by means of seed, which are produced very prolifically. Natural regeneration is fairly good and seedlings will often be found in large numbers near the parent tree. The seed is usually produced from about 40 years' old, or earlier if the trees are grown in the open ; after this seed years occur almost annually. Seed should be kept for a year before sowing, as it tends to lie dormant for the first year. One-year seedlings or 1 yr. 1 yr. transplants are best for planting out.

Ash is best grown in mixtures with other species, otherwise the ground tends to become covered in weeds, and the soil deteriorates. It also coppices well, and ash coppice is probably easier to sell than anything except sweet chestnut.

Diseases. The young trees are often badly cankered, and this is caused by a fungus, ash canker (*Nectria ditissima*). This is an infectious disease and when present all affected stems should be cut out.

Varieties. There are many varieties of ash, most of which are formed by grafting or budding. There are, for instance, various forms of weeping ash, *e.g.*, *Fraxinus excelsior* var. *pendula* Aiton., which has an umbrella-like head with drooping branches.

THE TIMBER. Ash is the toughest and most elastic of British timbers, and one of the most valuable hardwoods grown in this country. It is also better quality than ash grown in any other part of the world. The best quality comes from comparatively young trees (see also under ' Strength ') ; it should also be noted that in felling for sports' goods especially, the spurs at the base of the trunk should not be axed off, but the tree cut as low as possible, as some of the most valuable wood is found in the curves.

The sapwood is wide and yellowish-white to grey-white. When freshly felled the heartwood often becomes pinkish in colour, and later darkens to a pale brown. There is, however, frequently little distinction between the heart-wood and the sapwood, but often, in older trees, an irregular greyish or blackish discoloration in the centre (this is known as ' black heart ') ; this is not necessarily a defect, as the timber is normally quite sound when in this condition and no wood-rotting fungi have been associated with it, although it has been claimed that a certain amount of toughness is lost.

It is usually straight grained with a somewhat coarse texture, is fairly hard, but only moderately heavy, weighing from 33 to 55 lbs. a cu. ft., and on an average about 44 lbs. per cu. ft. when seasoned. When used for tool handles the timber becomes smooth in use in spite of its coarse texture.

A rather inconspicuous but attractive figure is obtained, especially when rotary veneer is cut, due to the contrast between the open spring wood and the dense summer wood (see p. 24 for anatomy).

When the timber is streaked with irregular dark markings it is called Olive Ash, but this type of timber is seldom found in England, being generally imported, often in the form of veneers.

DURABILITY. The timber is not particularly resistant to decay although winter-felled timber tends to be slightly more durable than summer felled. Logs of ash will often be found with the

markings of the ash-bark beetle on the surface immediately under the bark, but this does not adversely affect the wood. It is, however, prone to attack by the furniture beetle and the Lyctus. It can be easily treated with creosote either in the open tank or, even better, under pressure, being only moderately resistant to impregnation. Black-hearted timber is, however, very resistant to impregnation. Logs from old hedgerow trees very often are damaged by heart rot. Ash is highly resistant to fire.

SEASONING. Logs should be converted immediately after felling in order to avoid deep shakes which considerably reduce the value of the timber. It air seasons fairly well and rapidly. When kilning, care must be exercised to avoid warping, and high temperatures in the kiln must be avoided. (Kiln Schedule V recommended.) End splitting is rather common, but does not extend any great distance. Timber which has become distorted in kilning may be ' reconditioned ', that is to say treated with a high temperature steaming.

STRENGTH. Ash is extremely tough and elastic, but the quality of the timber varies considerably, depending on the part of the tree used and the age of the tree, thus the toughest material is found at the butt of the tree, whereas the strongest for a beam for upright (the greatest strengths in stiffness and compression) are found higher up the trunk. For sports' goods and similar purposes, where the maximum elasticity is needed, trees are best felled at 40 to 50 years, when the trunk is 10–12 ins. in diameter. On the other hand, for less exacting uses and where stiffness is more important, trees of 60–70 years old are better. Strength is also determined to a large extent by the rate of growth of the tree, and normally fast-grown ash is stronger than slow grown, it has also been stated that the best timber is found at 3–7 ins. from the heart.

Ash, especially if grown in unsuitable conditions, is frequently somewhat brittle, or ' brash '. This brashness has been found to be due to a number of causes, *i.e.*, adverse growth conditions, low density, high proportion of vessels and parenchyma or the presence of tension wood. Incipient decay and high temperatures in the kiln also produce brashness.

Ash bends easily when steamed if clean and straight-grained material is used.

WORKABILITY. When green the timber has a tendency to bind on the saw in conversion, but when seasoned it works well with most hand and machine tools and takes a good finish. It veneers well and can be glued and stained, and varnished without trouble. It also takes nails without undue splitting.

SIZES and AVAILABILITY. The supplies of high-quality ash suitable for sports' goods, etc., are limited, but there is a fair quantity of lower-grade timber. Logs are generally about 15 ft. long (maximum 30 ft.) and with a maximum width of 48 ins. (average 20 ins.). As already mentioned ash for sports' goods should not be more than 10–12 ins. in diameter.

USES. In the following list it should be noted that for tool handles and most sports' goods ash should be hand cleft in order to avoid cutting across the grain :

Agricultural implements, furniture, sports' goods, *e.g.*, tennis rackets, hockey sticks, gymnasium appliances, billiard cues, etc. Tool handles, *e.g.*, carpenter's tools, picks, shovels, axes, spades, etc. Motor bodies, omnibus and lorry bodies. Oars, sieve and riddle arms, wheelbarrow frames, veneers. Turnery, military drums, aeroplane construction (for which home-grown ash is preferred to all others), shafts for carts and coaches, felloes of wheels.

Coppice ash is used for hop poles, hurdles. (sheep, rick and racing hurdles), crates, walking sticks, hay cribs.

WHITE ASH

(*Fraxinus americana* L.)

A North American species, it grows to 120 ft. in the United States, with a diameter of 5–6 ft. It was introduced into Britain in 1724 and has proved one of the best American deciduous trees in this country. It grows rapidly and endures poorer and drier soils than English ash. It has not, however, been widely planted, but mostly as an ornamental tree.

The timber resembles that of English ash but is not of quite such good quality (see below)

IMPORTED TYPES OF ASH

EUROPEAN ASH. A small quantity of ash is imported from France ; this is of the same species as the English ash but is milder and less strong. A very small amount of Hungarian ash which was imported was mainly in the form of burrs which were cut into veneers for cabinet making.

AMERICAN ASH or CANADIAN ASH. Owing to the comparative scarcity of first-quality home-grown ash, some American species are imported and used fairly widely for the same purposes, although they are not of quite such good quality. There are several species of American ash, the principal ones being as follows :

White Ash (*Fraxinus americana* L.)—see above.

Green Ash (*Fraxinus lanceolata* Borkh.).

Black Ash (*Fraxinus nigra* Marsh).

The timbers of these three species closely resemble each other and are generally mixed more or less indiscriminately and sold as American ash.

The remaining twenty odd species of ash found in the United States are of minor importance; in fact, 98% of American ash is the product of the above three species.

The name 'white ash' is often used to refer to the timber of all species except black ash (*F. nigra*).

JAPANESE ASH or TAMO (*Fraxinus mandshurica* Rupr.). This timber was largely imported as veneer before the war, as it is frequently very highly figured; it was used for cabinet making, and, to a less extent, for panelling.

NOTE. All the above species will grow in Britain, but are usually only found as ornamental trees in botanical gardens.

BEECH

BOTANICAL NAME: *Fagus sylvatica* L.

FAMILY: *Fagaceae*, this includes the oak and chestnut.

DISTRIBUTION. Beech is native to England (but not to Scotland and Ireland) and most of the temperate parts of Europe. It is widely distributed: from Norway to the Mediterranean, and from England to the Caucasus and Persia; it is even found in Japan.

THE TREE. A very tall tree, often reaching 100 ft. or more in height, with a diameter of 4 ft. or more. When grown in close forest (which is often the case) the trunk is frequently clear of branches for 50 to 60 ft. When growing alone, it develops an enormous crown, the branches of which droop almost to the ground.

It is a very common tree, especially in the south of England and the S. Midlands; it forms large tracts of woodland in the Chilterns.

Soil and Situation. Beech is our most important tree for lime and chalk soils (where it attains its best growth). It is accommodating as to soil, but pure sands, very heavy clays, and acid peats, are unsuitable. Excessively rainy climates and shallow soils do not produce good growth.

It will succeed by the sea and may be used as a protection for other species; north and east aspects are more suitable.

Sylvicultural Characteristics. It is wind-firm, even on thin, gravelly soils, and is an excellent tree for a shelter belt. It will tolerate a considerable degree of shade and is widely used to underplant other species. The dead leaves form a rich humus, and for this reason beech is often used in mixed forests to improve the soil; so beneficial is it that it has been given the name 'mother of the forest'. It is, in fact, essentially a tree for mixtures, both from a sylvicultural and economic point of view.

It is somewhat tender to late frosts, especially when very young. The best sylvicultural rotation is about 120 years.

Cultivation. The seed is in the form of a small nut (known as 'Beech mast') which has some food value; the tree was planted by the Romans to supply pig food. Seed should be sown in spring, if sown in winter it will probably be destroyed by mice. Care of the tap root is essential in transplanting and 1 yr. 1 yr. 1 yr. transplants are best for planting out.

Diseases. Trees are sometimes attacked by a minute insect, the 'beech coccus', which clings in large numbers to the bark and reduces the trees' vitality by living on the sap. Often the trees die after prolonged attack and the wood decays. It is suggested that only sickly trees are attacked.

Varieties. There are very many garden varieties of beech, the best known of which is Var. *cuprea*, the Copper Beech; beautiful cut-leaved and weeping forms are also grown.

THE TIMBER. Beech varies in colour from almost white to warm red-brown (which colour may be intensified by steaming); the type of soil on which the tree grows influences the colour. Some people claim that the redder-coloured wood is grown on richer soil and is of better quality. There is little difference between the colour of heartwood and sapwood. It is characterised by very small spindle-shaped markings on plain sawn boards which are caused by the rather prominent rays; these occupy about one-quarter of the surface.

Usually straight grained and with a fine and even texture; it is hard and moderately heavy, weighing 40–55 lbs. per cu. ft. when seasoned (averaging about 45 lbs.).

DURABILITY. Beech is not very resistant to decay and should be treated with a preservative when used in the open. It is, however, very durable under water, and many of the piles supporting Waterloo Bridge and Winchester Cathedral were of beech.

It is immune from Lyctus beetle attack, but rather liable to be damaged by Furniture beetles; the bark should always be removed in order to avoid damage by Longhorn beetles.

Beech is one of the easiest timbers to impregnate with preservatives either under pressure or

by the open-tank method. It has very high fire-resistance properties.

SEASONING. Beech should be converted immediately after felling, and logs should not be left lying on the forest floor. The timber needs care in air seasoning to avoid checking and warping. It should be piled for seasoning when the weather is not too hot and dry. In kiln seasoning there is a slight tendency to split and warp, but this can be overcome with careful handling. (Kiln Schedule V recommended.) The timber is frequently steamed when fresh cut to accelerate subsequent seasoning, though this practice is of doubtful value. It is said, however, that the steaming improves the working qualities of the wood, and certainly has the effect of killing any fungal spores and helps to prevent surface infection by fungi. The steaming process has the effect of rendering the timber a pinkish colour.

STRENGTH. It is not often recognised that beech is one of the strongest of British timbers, being 20% stronger than oak in most strength categories, according to tests by the Forest Products Research Laboratory. It cleaves easily, especially after seasoning, but does not split, *e.g.*, in nailing.

Tension Wood. Specimens of timber of the same density often have very varied strength and working properties. Some timber will be found to have a silky, lustrous appearance on the sawn end grain and be weak in tension; have high shrinkage in a tangential direction and work in a very woolly manner. This is caused by 'tension wood' (93) which is found in trees growing out of the vertical and situated on the upper sides of the trunks (where abnormal tension is required to keep the tree from bending). Old woodmen in the Chilterns recognise the wood, which they term 'sleepy' beech.

WORKABILITY. Beech varies somewhat in its workability (see above), but generally is one of the best timbers for turnery, and for this reason is widely used for chair legs, cheap tool handles, kitchen utensils, etc. The timber also works fairly easily with most machine and hand tools, though there is some tendency for the saw to bind when green timber is being cut. It veneers excellently and has been used as plywood in the manufacture of plywood barrels. It also finishes well with a smooth surface and can be stained and polished easily. The timber bends readily on steaming, and this quality renders it valuable for such purposes as bentwood furniture, etc.

SIZE AND AVAILABILITY. Logs are usually of good size, up to 30 ft. long (average 15 ft.) and 48 ins. in diameter (average 20 ins.). There are considerable supplies, especially in such areas as the Chilterns, in spite of the heavy felling both during 1914–1918 and in the present war.

USES. Beech is used for a multitude of purposes, possibly the most important is for furniture (especially chairs) in the High Wycombe furniture industry. Other uses include:

Turnery:
- Bowls.
- Rollers for textile and other trades.
- Bobbins.
- Shoe heels.
- Shoe lasts.
- Tool and cutlery handles.

Domestic woodware:
- Spoons.
- Brush backs.
- Rolling pins and other kitchen utensils.

Flooring (beech makes excellent block or strip flooring).
Motor body building.
Wrest planks for pianos (selected material).
Boat building.
Ship's wedges.
Toys.
Mallets.
Trawl beams.
Carpenter's planes.
Pit props.
Railway sleepers.
Wood type (printer's).
Fuel (with ash, the best wood for burning. The chief fuel of Europe).

IMPORTED BEECH

Although large quantities of beech are obtainable in Britain, a considerable amount of the same species was imported from Central Europe before the war. This was often of a mild nature and was preferred for some purposes to the home-grown; also its price was often low enough to prevent the more general use of the home-grown timber.

OTHER SPECIES OF BEECH

NORTH AMERICAN BEECH (*Fagus grandifolia* Ehrh.). Similar to English beech but generally rather inferior. Only small quantities are imported.

Very closely allied species in the southern hemisphere belong to the genus *Nothofagus*; these are very similar to *Fagus* spp. but are usually more pink in colour, and lack the broad rays. The best known timbers are Tasmanian Beech (*N. Cunninghamii* Oerst.) and Red Beech (*N. fusca* Oerst.) and Southland Beech (*N. Menziesii* Oerst.) from New Zealand.

BIRCH

BOTANICAL and COMMON NAMES: There are two very similar species of birches which are almost equally common in Britain, *i.e.* :

Betula pubescens Ehrh. White Birch or Black Birch.

Betula pendula Roth (sometimes known as *B. verrucosa* Ehrh.) : Silver Birch or Common Birch.

The name *Betula alba* was originally given by Linnæus to the birch, but this species has been divided into the above two species, although the term *B. alba* is still found in some text-books.

FAMILY : Birch, like hornbeam and alder, belongs to the family *Betulaceae*.

DISTRIBUTION. Both species are native to Europe (including Britain) and have a wide distribution, being particularly characteristic of northern and mountainous regions.

THE TREE. Birch grows to a maximum height of about 70 ft., and with a diameter of up to 2–3 ft., but 1 ft. 6 ins. is more common. Clean boles of 30 ft. are obtainable. Under very adverse conditions it may be reduced to a shrub. The well-known silvery bark peels off in horizontal papery layers ; at the base of the tree the bark becomes dark and very rugged (less so in the case of *B. pendula*, which tends to remain smooth to the ground).

The two species are easily identified, as the twigs of *B. pendula* are rough and warty and the branches are more pendulous. With *B. pubescens* the twigs are downy, the branches tend to be more erect, and the bark darker than *B. pendula*.

Soil and Situation. It is very tolerant with regard to soil and climate, and will grow on almost any soil that is not too wet and heavy. Any aspect is suitable and it will flourish at elevations of up to 2,500 ft. on the almost soilless mountains of Scotland, where it will grow better than any other broad leaf tree. *B. pubescens* affects rather moister habitats than *B. pendula* (*e.g.*, the Highland glens). So hardy is birch that it grows further north and at higher altitudes than any other European tree.

Sylvicultural Characteristics. Birch grows fairly rapidly and also seeds heavily at an early age. For this reason it quickly colonises. It has the ability of growing through a heavy growth of weeds, and so is usually the first tree to appear on felled areas ; if left it will kill out most other trees, as its thin branches whip out the tops of other species. Because of this habit it is usually regarded as a weed tree in forestry.

Birch is frost hardy and seldom damaged by rabbits. It demands plenty of light, and is usually found in clumps in a wood or fringing the edge.

It is a useful tree in conifer plantations at high altitudes, as it adds humus to the soil. It is extremely wind-firm and is planted as shelter belts and fire stops along the side of railways to protect coniferous crops.

It is not a long-lived tree and should be felled at about 30 years for small dimension timber. If properly grown there appears to be no reason why it should not be grown as a crop for plywood, in which case a longer rotation would be necessary.

Use of Twigs. The twigs are used for besoms, forest fire-fighting beaters, horse jumps, in the manufacture of steel plates, and also in the production of vinegar (where bundles of twigs are placed in the bottom of vats to clarify the liquid. Young twigs, 3–6 years old, should be used).

Use of Bark. The bark is used for tanning leather ; Russian leather is treated by this method.

Cultivation. Birch is raised from seed, which should be sown in March. It is, however, seldom deliberately cultivated as a forest tree, though often as an ornamental or shelter tree ; also it colonises so readily that it is more often cut out than planted.

Diseases. It is apt to be attacked by fungi and insects ; the timber is often damaged by a fly (*Agromyza carbonaria*) which causes 'pith flecks,' as already mentioned in alder.

A very common fungus attacking birch trees is *Polyporus betulinus*, which causes heart rot and forms white, bracket-like fruit bodies that project from the trunks. Usually only trees that are not growing well or are over-mature are infected.

Varieties. There are a number of varieties of both species, the most interesting of which are :

B. pendula forma *tristis* (Beiss.) Schneid.—Weeping Birch.

B. pendula forma *Youngii* (Th. Moore) Schneid.—Young's Weeping Birch. This is the best of the weeping types, and is suitable for small gardens.

B. pendula forma *purpurea* (Andre) Schneid.—The leaves are purple.

B. pendula var. *fastigiata* (Clemenceau) K. Koch. The branches are pressed close to the stem ; closely resembles Lombardy poplar.

B. pubescens var. *aurea*. Leaves yellow when young.

There is another species of birch occurring locally in the mountains of Northumberland and Scotland ; this is the Dwarf birch (*B. nana* L.). It is of no importance commercially.

THE TIMBER. Birch is white in colour, or

occasionally pale brown ; moderately soft, close-textured, and fairly straight grained. There is no distinct heartwood nor figure. It weighs about 42 lbs. per cu. ft. when air dry.

DURABILITY. It is not resistant to decay and is apt to be attacked by the furniture beetle. When used in the open it should be treated with a preservative and it is easily impregnated with creosote (and other liquids).

SEASONING. It seasons rapidly either in kilns or by air drying methods. (Kiln Schedule VI suggested.) There is some tendency to warp. Being prone to attack by fungi, converted timber should be dried as quickly as possible ; large piling sticks and narrow stacks should be used. Poles of birch often have parts of the bark removed to promote more rapid drying.

STRENGTH. Birch is a tough and stiff timber ; limited tests have shown that it is harder and stronger in compression along the grain than Finnish birch but otherwise has very similar strength properties.

WORKABILITY. When properly seasoned birch works well with most hand and machine tools ; it is particularly suitable for turning. There is occasionally a tendency to pick up in planing cross-grained material. When breaking down the timber may bind on the saw, especially if the wood is at all woolly.

SIZE and AVAILABILITY. Under normal conditions most of the birch used in the country is imported from Finland and Central Europe. Canada also supplies large quantities of yellow birch (see below). Home-grown logs are usually up to 20 ft. long (average 10 ft.) and up to 12 ins. in diameter (average 6 ins.).

USES. Home-grown birch is mainly used for furniture, especially chairs ; it is very suited to this purpose, as it is easy to bend and stains to the colour of any wood, as well as being tough and hard wearing. Other uses are : motor-body framing ; clogs, bobbins and other turned articles ; brush backs, toys, boxes, slack cooperage, clothes pegs, skewers, bungs for beer barrels, etc. Birch poles are used for stirring molten metals in the non-ferrous metal industry.

Unfortunately the percentage of large logs which are reasonably clean is too small to permit a very wide use of birch, but it would probably be worth planting birch on a wider scale as it is a very useful utility wood.

IMPORTED BIRCHES

CANADIAN YELLOW BIRCH (*Betula lutea* Michx.). Heartwood light golden brown ; the timber is stronger than European birch ; very large quantities are imported to make into plywood for aircraft—it is the best timber for this purpose. Occasionally grown in Britain as a specimen tree.

CHERRY (or SWEET) BIRCH (*Betula lenta* L.) From N. America ; heartwood pinkish-red. It is harder, heavier and somewhat stronger than yellow birch, but is more scarce. Introduced into England in 1759, it is occasionally grown for ornamental purposes.

PAPER or WHITE BIRCH (*Betula papyrifera* Marsh.) is similar to the European species, being white in colour, and of about the same weight. It is mainly used for turnery : spools, bobbins, tool handles, etc. Introduced in 1750, it has not been widely planted.

CHERRY

BOTANICAL NAME : *Prunus Avium* L.

FAMILY : *Rosaceae ;* the Rose family is an extremely large one, and widely spread. Included in it are a number of fruit trees, *e.g.*, apple, pear, plum, peach, nectarin, apricot, almond, and also such fruits as raspberries, blackberries, and strawberries. Amongst British trees and shrubs are : service tree, whitebeam, mountain ash and hawthorn. Apart from roses there are a large number of purely ornamental flowering plants belonging to the family.

COMMON NAMES : Gean, Mazzard ; English or Wild Cherry.

DISTRIBUTION. This species is native of practically all countries of Europe, including Britain, also as far east as Asia Minor and the Caucasus.

THE TREE. Cherry attains fairly large sizes, especially when growing among other broadleaf trees ; it may grow to 60 or 70 ft., with a diameter up to 2 ft. or occasionally more in very well-grown specimens.

It is a common tree in most English woods, and especially beech woods.

Soil and Situation. It will grow on most soils, but prefers a moist, fairly deep soil containing some lime. It also succeeds on poor, chalky soils, but does not attain its best development under such conditions. Any aspect is suitable.

Sylvicultural Characteristics. Cherry demands a fair amount of light, although as coppice it will endure a light shade. It is fairly frost hardy ; is not a long-lived tree and reaches maturity at about 60 years, or 80 years at the utmost.

Cherry can only be regarded as a minor tree, but it is highly ornamental with its mass of white blossom in the spring, and the red autumn tints of its foliage. It is, therefore, a valuable addition to woods, hedgerows and large gardens.

Cultivation. The tree may be grown from seed (*i.e.*, the stones of the fruit), which should be planted soon after ripening as they quickly

lose their vitality. Cherry coppices well, and also sends out suckers.

It is the parent stock from which most of the edible cherries have been cultivated, especially the black varieties.

THE TIMBER. Cherry has not, until recently, received the attention that this attractive wood deserves. It is hard and has a fine even texture, and is generally straight grained.

The heartwood is of a light reddish-brown colour, which darkens on exposure, and with polishing, to a similar appearance to that of mahogany. The red-brown mahogany colour can be intensified by soaking the wood for several days in lime water. The sapwood is of a pale colour, usually yellowish or pinkish.

It is moderately heavy, varying from 35 to 50 lbs. a cu. ft., but averaging about 40 lbs. when seasoned.

Quarter-cut surfaces show a slight 'silver grain,' caused by the rather wide rays.

DURABILITY. It is not resistant to fungal attack, but is immune to Powder Post beetle (or Lyctus), and the sapwood is liable to attack by common Furniture beetle. The pews in a church at Gibside, Northumberland, were made of Cherry, in 1812, and they have not moved or shown any signs of deterioration to this day. Its resistance to fire is low.

SEASONING. Air seasons and kiln seasons fairly readily, but requires care to avoid warping. (Kiln Schedule V suggested.)

STRENGTH. Cherry is very tough and compares very favourably with oak in most strength categories. It is much superior to oak in splitting, and is equal in bending strength, crushing along the grain, stiffness and in hardness.

WORKABILITY. The sawing qualities of this wood are excellent, cutting cleanly with all types of saws. It is comparable to mild ash in general working properties. There is a slight tendency to cross-grain near the butt of the tree, which requires care in finishing, otherwise the timber finishes well. For turning, glueing, staining and polishing, this timber is admirable.

SIZE and AVAILABLITY. Well-grown large trees suitable for conversion into furniture and panelling stock, are limited and scattered, but planks can be obtained in fairly large sizes, as, for example, 6 ft. to 12 ft. long.

USES. At one time this wood was in much demand for furniture, panelling, inlay, musical instruments and turnery, but whilst the demand dropped, of late it has tended to be in demand for modern panelling, high-class joinery and cabinet making. It is used as substitute for antique mahogany, especially for repairing furniture. Cherry-wood pipes and walking sticks are usually made from an imported species (*Prunus Mahaleb* L., the St. Lucie cherry).

BIRD CHERRY

(*Prunus Padus* L.)

Also called Wild Cherry or Wild Black Cherry.

The tree is smaller than the gean, seldom exceeding 50 ft. in height. It occurs mostly in the North of England and Scotland.

The timber is very similar to that of the gean, but the heartwood is lighter in colour.

SWEET CHESTNUT

BOTANICAL NAME : *Castanea sativa* Mill. In some older reference books the names *Castanea vesca* Gaert. or *Castanea vulgaris* Lam. are often used.

FAMILY : *Fagaceae.*

COMMON NAMES : Spanish Chestnut, Edible Chestnut, Chestnut.

DISTRIBUTION. The tree has a fairly wide distribution throughout Southern Europe, North Africa and Asia Minor. It is not indigenous to this country, and was believed to be introduced by the Romans at the time of their conquest of Britain.

THE TREE. Chestnut forms a very large tree, often over 100 ft. in height, but is particularly remarkable for its immense diameters, which may exceed 10 ft., although normally sound trees are seldom more than 4 to 5 ft. in diameter.

As it is seldom grown in close forest, but in open conditions the length of clear bole is rarely more than 20 ft.

Soil and Situation. The tree is fairly accommodating as to soil, but thrives best on a light, deep and moist loam. It should, however, never be planted on chalk, or even where there is a small percentage of lime, as it will become sickly and probably die off. Certain types of soil affect the quality of timber, those allowing the fastest rate of growth (*e.g.*, fairly light loams, and especially greensands) are best ; on poor sands and gravels the stem is apt to become ring-shaken.

Chestnut is essentially a tree for a warm climate and will seldom attain valuable size and produce first quality timber except in the South of England (where it is one of our most important hardwoods). Under favourable circumstances, however, good sized trees may be found in the North of England and Scotland; for instance, Mr. F. R. S. Balfour reports fine trees in Peeblesshire. Nuts are seldom ripened in the colder northern parts of Britain.

Sylvicultural Characteristics. The tree is fairly

wind firm and will endure light shade when young, and especially when grown as coppice under standards. The young plants are very tender to late frosts, and even when mature, suffer in this way. It is a rapid grower and may attain a great age, though in old trees the timber is frequently much shaken. It coppices freely, and stools may be cut over many times without impairing the vigour of growth.

Chestnut improves the soil owing to its heavy foliage, and compares with beech in this way.

Cultivation. Chestnut is best grown in an open manner, if grown in close forest the rate of growth is slow, and the timber of poor quality. For timber it is best to use a rotation of 80–100 years, but it is probably most profitable as coppice on a short rotation; on good soil (as in parts of Sussex) a short rotation of 7–14 years is used. The coppice shoots are valuable for split-pale fencing, hop poles, etc. An even shorter rotation of 2–4 years may be used for the production of walking sticks.

Diseases. The chestnut disease, which has proved so fatal in America, fortunately does little damage in Britain, but there is some 'ink disease,' caused by *Phytophthora cambivora*, which occasionally kills isolated trees or groups.

THE TIMBER. The timber of chestnut strongly resembles that of oak, having a yellowish-brown sapwood and a darker brown heartwood. In the plain sawn boards, it is almost indistinguishable from oak, but the lack of the characteristic silver grain of oak marks it out immediately when quarter sawn. In its properties also it resembles oak, but is less valuable as it frequently has defects such as spiral grain and cup or ring shakes, and also tends to be coarser in texture and lighter in weight. It is not quite so heavy as oak, weighing about 35 lbs. per cu. ft., whereas oak weighs about 46 lbs. a cu. ft. Much of the famous so-called oak timber in historic buildings is a mixture of chestnut and oak. Part of the ancient structure of the roof of St. Alban's Cathedral was of chestnut.

DURABILITY. The timber is very durable, comparing well with oak, and is suitable for outdoor work without treatment. Occasionally it is infected with the 'Beef-steak' fungus (*Fistulina hepatica*) which, in oak, produces the well-known 'Brown Oak.' Here it colours the chestnut a dark warm brown. It is susceptible to damage by wood-boring beetles, especially the sapwood. It is a difficult timber to treat with preservatives, as it is very resistant to the impregnation of liquids, even under high pressure. Standing trees are seldom affected by heart-rot. It is highly resistant to fire.

SEASONING. Chestnut is a difficult timber to season, especially in kilns. There is a tendency to collapse and to retain areas more moist than others. However, with care this can be overcome. (Kiln Schedule IV suggested.)

STRENGTH. Although chestnut has been used as a substitute for oak, its strength values are somewhat inferior, and its resistance to splitting is about 30% less. This weakness is utilised by the manufacturer of split-pale fencing.

WORKABILITY. When converting the log there is a tendency for saws to bind. It is an easy timber to work, both with machine and hand tools, and finishes excellently with a smooth surface, taking polish and stain well, and can be glued without trouble. When seasoned it can be bent easily.

SIZES and AVAILABILITY. Very large logs of chestnut are not easy to dispose of, as they are often badly shaken and have spiral grain. Generally logs are up to 30 ft. long (average 15 ft.) and up to 30 ins. in diameter (average 15 ins.).

USES. It is often used as a substitute for oak in cabinet work, gates and posts, beams, etc., and is also used for coffin boards, staves, ladder rungs, window cills, flooring, and as veneer. The High Wycombe chair industry uses considerable quantities for chair legs.

Chestnut coppice poles are mainly used for split-pale fencing, and this is now an important trade. Hop poles and walking sticks are also made from coppice wood.

IMPORTED CHESTNUT

AMERICAN CHESTNUT (*Castanea dentata* Borkh.) is very similar to the common chestnut. It is usually imported in so-called 'sound wormy' grades, *i.e.*, attacked by pin-hole borers which disfigure the timber with numbers of small holes but do not seriously affect the strength, and there is no danger of the trouble spreading, as the insects do not work in seasoned timber. The wood is mainly used for cores for veneering in furniture.

CHESTNUT—HORSE

BOTANICAL NAME: *Aesculus Hippocastanum* L.

FAMILY: *Hippocastanaceae* (included under the major family *Sapindaceae*).

The word 'Horse' in the common name was probably derived from the fact that the Greeks and Turks used the seed as a cure for certain diseases of horses, or else merely to denote the seeds' inferiority to those of the Sweet Chestnut. A third alternative is that the leaf scar on the twig is in the shape of a horse's hoof.

DISTRIBUTION. The tree is a native of the

mountainous regions of North Greece and Albania (at an elevation of 3,000 to 4,500 ft.) and also of Iran and the Caucasus. It came to Western Europe by way of Constantinople, through Austria to France and England, being introduced into this country between the middle of the 16th and the early 17th centuries.

THE TREE. A large tree, 70 to 80 ft. high (sometimes 100 ft. or more) and 4 to 6 ft. in diameter. Owing to the fact that it is usually grown in the open and not in closed forest, the length of clean bole seldom exceeds 20 ft. It is a very handsome tree, with a huge crown which bears showy spikes of white blossom in the early summer. As an avenue tree it is particularly suitable, and frequently used.

Soil and Situation. The tree thrives best on a good, rich and fairly dry loam. It is a hardy tree and will grow on any aspect, but the branches are apt to be broken if the situation is too exposed. In order to obtain the best development it should be planted in low elevations in a warm climate and sheltered situation.

Sylvicultural Characteristics. Horse chestnut is fairly wind firm and will bear a light overhead shade, but prefers full illumination and succeeds best when grown by itself. Where late frosts are frequent there is a tendency for the nuts not to mature. It grows rapidly but is not excessively long-lived (seldom more than 200 years), if grown for timber, an economic rotation would be from 80 to 100 years.

Cultivation. The nuts (known colloquially as 'conkers') are produced when the trees are about 20 years old, and ripen in October. Seedlings may be raised from them, but they should be sown soon after ripening or they will lose much of their power of germination.

Diseases. The main disease affecting the tree is a fungus (*Nectria cinnabarina*) which sometimes kills the crown. It may be recognised by masses of small bright red spots (the fructifications) appearing on the branches.

Use of Nuts. The nuts are not eaten by horses, but cattle, deer and sheep readily consume them. They may be pounded in water to make a substitute for soap, as they contain 10–12% of saponin. At present (1942) the Government is organising the collection of the nuts on a large scale, since saponin can be used not only as a soap substitute but also in certain fire-fighting appliances.

Varieties. There are a number of forms in cultivation, probably the best of these is Var. *flore pleno* which has double flowers that last longer than in the wild form. Also, there being no nuts, there is no chance of the tree being damaged by boys in search of 'conkers.'

THE TIMBER. The timber is white in colour, sometimes slightly yellowish. There is no distinct heartwood. It is soft, absorbent and light in weight, weighing about 30–32 lbs. per cu. ft. when seasoned (about the same weight as European Redwood). It is often somewhat cross- or wavy-grained; the texture is very fine and even.

DURABILITY. It is very liable to be attacked by fungi and should never be used in the open without some form of preservative treatment. It may be attacked by the Furniture beetle, but is immune from the Powder Post beetle (Lyctus). It is easily treated with croesote, which it absorbs readily.

SEASONING. Little trouble is experienced in seasoning Horse chestnut; it dries fairly quickly and with little degrade. It should be converted from the log as soon as possible, and put into stick immediately if the pure white colour is to be retained. If this is not done there is a tendency for the timber to become yellowish. Preferably the trees should be felled in early winter. (Kiln Schedule VI suggested.)

STRENGTH. So far no full-strength tests have been made, but the timber has not high strength properties, being soft and rather brittle. It bends quite easily, but seasoned wood, free from knots, should be used.

WORKABILITY. The wood works easily, when seasoned, with all hand and machine tools. When green it is somewhat woolly. It turns and carves well and takes glue exceptionally well. It may be stained to any colour and takes a good polish.

SIZES and AVAILABILITY. There are comparatively limited supplies available; logs are up to 25 ft. long (average 12 ft.) and up to 30 ins. in diameter, sometimes more (average 20 ins.).

USES. The clean, white appearance of the timber makes it very suitable for such purposes as dairy and kitchen utensils, especially as it can be scrubbed. The fact that it is very absorbent renders it ideal for racks and trays for storing fruit, since it keeps the fruit dry and so prevents rotting.

Other uses include: flooring—in situations where there is not heavy wear; turnery; boxes; cheap carving; rollers for blinds; broom handles, patterns, toys, etc.

RED-FLOWERED HORSE CHESTNUT

(*Aesculus carnea* Hayne.)

A smaller, less vigorously growing tree than the Horse chestnut, it is quite common as an ornamental tree, often being preferred on account of its dark foliage and red flowers. It

is probably a garden hybrid between *Aesculus Hippocastanum* L. and *Aesculus Pavia* L. (Red Buckeye, an American species with red flowers, now rare in Britain), but can be raised true from seed. It was first known about 1820. Frequently it is grafted on to the common Horse chestnut in order to obtain a larger tree with red flowers.

The timber is identical to that of the common Horse chestnut.

IMPORTED HORSE CHESTNUT

YELLOW BUCKEYE (*Aesculus octandra* Marsh.). This species is found in the eastern United States, and is very similar to the British species. Its uses in America include : wood wool, artificial limbs, pulpwood, slack cooperage, plywood, etc.

OHIO BUCKEYE (*Aesculus glabra* Willd.). Also a U.S. timber, it is often sold with Yellow Buckeye ; the latter may be distinguished in that it possesses distinct ripple marks.

It is used for the same purposes as Yellow Buckeye.

JAPANESE HORSE CHESTNUT (*Aesculus turbinata* Blume.). Also known as TOCHI or Japanese Chestnut. Before the war a small amount of this timber was imported for decorative purposes. It is darker than the British species, being golden-brown in colour and often contains mottle figures and marked with dark lines (the result of insect attack whilst the tree was growing).

It was mainly used in the form of veneer for cabinet work and interior decoration.

ELM—COMMON

BOTANICAL NAME : *Ulmus procera* Salisb. Formerly the name *Ulmus campestris* L. was used, but this name, given by Continental botanists, actually applies to *U. carpinifolia* only, and is an elm commonly found in (and native to) Central and Southern Europe.

FAMILY : *Ulmaceae*, apart from the elms, this family includes the Hackberries (*Celtis*) spp., which produce similar timber to elm but are little grown in Britain ; other genera are found in tropical countries.

COMMON NAMES : Red Elm, English or Common Elm.

DISTRIBUTION. The common elm has recently been found to be native to Britain and probably endemic.

THE TREE. Elm is one of the commonest trees in England, being planted for ornament more than any other—with the exception of oak. Hedgerows in many southern counties are characterised by the numbers of elms.

The tree attains very large sizes ; 100 ft. in height is not uncommon, and there are specimens of 130 ft. or more ; diameters are often 3–5 ft., and may be up to 8 ft. Unfortunately, in many cases trees of very large sizes are hollow or rotten in the centre.

Elm produces comparatively few large branches, but a mass of smaller ones, the former are apt to develop rot in the centre and to drop off, even on a still day, and are dangerous in avenues and parks.

Soil and Situation. Elm prefers a deep, porous and moist soil, as it is rather exacting with regard to moisture and mineral foods. It thrives best in low lands and valleys, and needs a southern aspect if in hilly country.

Sylvicultural Characteristics. The tree is very apt to be blown by the wind, except when young, because the large taproots almost invariably rot, and so leave the tree without any good anchorage ; the rot often extends up the trunk in older trees. Elm must be classed as a light-demander, but it will bear a very light shade, rather more than oak or ash.

In spite of its preference to a mild climate, elm is fairly hardy against frost.

It grows rapidly, but is short lived, attaining maturity at about 80 years old, after this age there is a danger of heart rot and poorer quality timber generally ; it is advisable, therefore, to fell at about 80 years.

Cultivation. Only a very small percentage of the enormous quantity of seed produced is fertile and the tree is best cultivated by suckers, which are produced in abundance ; they may easily be detached and planted out.

Diseases. Elm is rather prone to attack by fungi and insects. Damage is often done, especially to sickly trees, by the elm bark-beetle (*Scolytus destructor*), and this insect was probably the cause of introducing the now famous Dutch elm disease (caused by a fungus, *Ceratostomella ulmi*), which has proved so destructive in England, especially in the eastern counties, during recent years. It attacks old and young trees, killing the foliage and often causing the tree to die, although more trees recover than was first thought to be the case.

THE TIMBER. Elm is very much better timber than is normally recognised. It has had a reputation for warping badly owing to its somewhat twisty grain. This, however, can be overcome with careful seasoning, and it has been used very successfully for furniture and panelling. The heartwood is a dull brown or reddish brown,

and the sapwood yellowish white, narrow and clearly defined.

It is coarse textured, hard and firm. Plain sawn timber is usually attractively figured due to the uneven growth of the annual rings, fine zigzag markings between the rings are due to wavy bands of summer wood vessels (see Fig. 12).

Elm is fairly light, weighing from 33–43 lbs. a cu. ft. (averaging about 35 lbs.) when seasoned.

DURABILITY. In the open where it is subjected to alternate wet and dry conditions, elm is not extremely durable. It has, however, great resistance to decay when completely submerged, and an example of this is the elm piles which were extracted from the foundations of Waterloo Bridge, which had been in position, carrying the weight of the bridge, for a hundred and twenty years. It is also said that the Rialto at Venice stands on 1,200 elm piles.

Elm drain-pipes are frequently being dug up, and are also found to be in an excellent state of preservation. An interesting point in connection with this is that these drain-pipes were usually made from sections of round logs hollowed out and one end tapered in order to fit into the next pipe; it is from this method of making drains that the phrase 'driving a main' originated.

The sapwood is apt to be attacked by Lyctus beetle and reduced to powder. The Furniture beetle is often found, and the Death Watch beetle occasionally in structural timber. Standing trees of any size are extremely likely to suffer from heart rot. The timber of common elm has a very low resistance to fire, that of wych elm is considerably more resistant.

SEASONING. There is a distinct tendency for elm to warp during seasoning; this may be minimised by piling sticks near together when air seasoning, and using a low temperature in the kiln. (Kiln Schedule I recommended.) The trouble may also be largely met by 'reconditioning,' which consists of kilning the timber and allowing it to warp to its full extent, and then kilning again with a high temperature steaming process. This has been found to be very successful, and it has increased the usefulness of the timber considerably.

If end piled it can be air seasoned successfully in wide boards.

STRENGTH. It is a strong, very tough timber and is particularly difficult to split. According to tests carried out by the Forest Products Research Laboratory, English elm is about 30% inferior in most strength properties to English oak; its twisted grain, however, makes it more difficult to split than oak.

WORKABILITY. Because of its twisted grain, elm is rather difficult to saw, often binding on the saw, but otherwise it works fairly well with both hand and machine tools, although there is a tendency for it to 'pick up' when planed. It takes nails without undue splitting, also a good finish.

SIZE and AVAILABILITY. Large logs are easily obtainable up to 50 ft. long (average 20 ft.) and 5 ft. in diameter (average 2 ft.). As previously mentioned, the larger logs are often rotten in the heart. There is an abundant supply of common elm, and after a strong gale, when many trees have blown down, there is sometimes a glut.

USES. Probably the best known use for elm is for coffin boards, but it is also very widely used for the ends of packing cases owing to its toughness and because it holds nails well. Various types of boxes, such as those for tin plates and ammunition, are made entirely of elm. Owing to its durability under water elm is suitable for wharf construction, piles, etc. Among other uses for elm may be mentioned wheelbarrows, waggons, weather boards (these are usually 'waney edged,' *i.e.*, without the edges being cut), cattle cribs, mangers, naves of wheels and large felloes, butcher's blocks, coach-building, maul heads, various handles, turnery (*e.g.*, bowls) water-cooling towers and road-paving blocks.

In boat building elm is used for the keels of smaller boats, yachts and fishing smacks, for dead-eyes for ships' rigging and pulley blocks of various types. Trawl rollers are often of elm. Burrs on elm are fairly common, and these provide highly decorative veneers.

Elm has been used very successfully for panelling, both in the solid and as a veneer. An excellent example of this is in the Board Room at the Forest Products Research Laboratory, Princes Risborough, where solid elm panelling has shown no sign of movement after several years' installation. With careful seasoning and selection of material elm can be used for furniture (tables, chairs, etc.)—apart from Windsor chair seats, for which purpose it has been used for many years.

OTHER SPECIES OF BRITISH GROWN ELM

There are several species of elm apart from *Ulmus procera* which are used for timber and grown in this country. The most important of these is the Wych Elm, and there is also a certain amount of Dutch Elm and a small quantity of Cornish Elm.

WYCH ELM

(*Ulmus glabra* Huds.)

Also known as SCOTCH ELM and sometimes MOUNTAIN ELM or WITCH HAZEL; the botanical name of *Ulmus montana* Stokes in With. is used in many text-books.

The tree is native to Britain and is more widely found in Northern Europe than common elm, as it endures a greater degree of cold and is also more accommodating as to soil and situation and is fairly wind firm. It grows fairly well on stiff loams but dislikes sandy soils. It is more abundant in the North of England and Scotland than in the south. A rotation of 80–100 years is suitable.

It is a somewhat smaller tree than common elm and tends to branch lower down, and the crown is much larger. Most authorities state that it does not produce root suckers, but the seed is fertile.

THE TIMBER. The heartwood of wych elm is usually paler in colour than the English variety, and often has a greenish tint. Generally speaking it is a better quality timber than either the Dutch or the English elms, being straighter in the grain, finer textured and less liable to warp. It is heavier, being about 43 lbs. per cu. ft. when seasoned. It is stronger than either of the other elms, and is particularly tough and elastic: its properties approach those of ash. It is also easier to work, being straighter in the grain, and bends readily when seasoned. Logs are mostly about 20 ft. long (max. 40 ft.) and 15 ins. wide (max. 30 ins.).

USES. The uses of wych elm and English elm are much the same, but the former is better for such purposes as bent shafts and where it is necessary to have an elastic timber or one which can be bent.

In shipbuilding it is used for keels, ribs and bottom boards.

Other uses include slack cooperage and steamed bent-wood parts.

DUTCH ELM

Ulmus hollandica Mill. var. *major* (Sm.) Rehd.

Also known as *Ulmus hollandica* Mill. and *U. major* Sm. This species is a hybrid between wych elm and the smooth-leaved elm (*U. nitens* Moench.).

THE TREE. A large tree, 120 ft. or more in height, and 4–5 ft. in diameter, it is fairly frequent in hedgerows in the South of England. It throws up a number of root-suckers, which are often corky, as also are the twigs. The seed is mostly infertile.

THE TIMBER. Very similar to common elm but bends easily, is considerably tougher and planes more readily to a good finish. It is used for the same purposes.

CORNISH ELM

(*Ulmus stricta* Lindl.)

Although smaller than common or wych elm, it grows 80 or 100 ft., and its fastigiate habit gives it the appearance of a Lombardy poplar. It is found mainly in Cornwall, Devon and Somerset.

THE TIMBER. Lighter in colour even than wych elm, Howard (38) describes it as 'superior in quality and texture to either the common English elm or the wych elm, and more nearly resembles the American rock elm, although not so hard, tough and white.'

There is very little of the timber available, as the tree is comparatively rare, but it is useful for planting in avenues, etc.

There are several other species of elm growing in Britain, *e.g.*, the smooth-leaved elm (*U. carpinifolia* Gleditsch.), which is mostly found in the eastern counties; Plot elm or Lock elm (*U. Plottii* Druce), found occasionally in the Midlands.

IMPORTED ELMS

CANADIAN (or AMERICAN) ROCK ELM (*Ulmus Thomasi* Sarg.—also known as *U. racemosa* D. Thomas). Possibly the best elm in the world; it is whitish, tough, heavy, straight grained, very strong and elastic. It is very largely used in shipbuilding.

AMERICAN or WHITE ELM (*U. americana* L.). Light brown or greyish in colour, strong and tough, but not equal to rock elm.

HORNBEAM

BOTANICAL NAME: *Carpinus Betulus* L.

FAMILY: *Betulaceae.*

DISTRIBUTION. Hornbeam is native to Central Europe and also to the eastern part of England at least, if not to the whole south. It is found in Italy, parts of Southern Russia and Asia Minor.

THE TREE. Under suitable conditions Hornbeam reaches a height of 80 ft. or more, with a diameter of 2–3 ft., but usually it is a small tree with only a short length of clean bole.

It is a very common tree in hedgerows, and often found as a forest tree with beech, and is frequently confused with this tree, to which it bears a strong resemblance; it can, however, easily be distinguished by the toothed edge of the leaves (those of beech being entire) and by the buds, which are short and pressed against the twig, those of beech being long, spindle-shaped and projecting from the stem.

The trunk is usually heavily fluted and often

somewhat flattened so as to be elliptical in section.

Soil and Situation. Hornbeam thrives best on a good, deep, sandy loam, but it will succeed on most types of soil, even poor sands and flinty clays, but will not attain any good size on heavy clays or in very wet situations. It is often found on chalk with beech.

It is mainly a tree for low elevations, but will succeed better than almost any other tree in cold, damp situations ; it prefers northern and eastern aspects.

Sylvicultural Characteristics. The tree is of minor importance in forestry, but is most useful as a substitute for beech for underplanting light-demanding species (as it bears considerable shade), especially in frosty or damp localities, it being very hardy against frost.

It should be felled at, or before, 100 years old, as it frequently goes ' stag-headed ' (*i.e.*, the top branches die off) and the bole begins to become unsound after this age is reached.

Cultivation. Hornbeam produces abundant seed from about 30 years of age, and this germinates freely. It also coppices freely and may be used for underwood in all but the heaviest shade. It makes an excellent hedge as it will stand cutting back, and retains its dead leaves, when clipped, throughout the winter.

Varieties. Two very useful and beautiful varieties of hornbeam (from an ornamental point of view) are var. *columnaris* and var. *fastigiata*, both of which have a fastigiate habit, like the Lombardy poplar.

THE TIMBER. The timber is almost dead white with light greyish flecks (which are the wide rays), and a somewhat lustrous surface ; it is dense, hard and moderately heavy—about 43 lbs. per cu. ft. when seasoned. The texture is fine and even, but it is frequently cross-grained, which makes it difficult to split. There is no difference in colour between the sapwood and the heartwood, and seldom, if ever, any figure.

DURABILITY. Hornbeam is not very resistant to fungal decay, but is seldom attacked by insects. It easily absorbs preservatives and can well be used for exterior purposes if treated by some such method of preservation as the hot and cold steeping method of creosoting. It is highly fire-resistant.

SEASONING. It seasons readily, either with kilns or in the open air, but there is some tendency to split, shake, distort, and occasionally to show a surface staining. (Kiln Schedule V suggested.)

STRENGTH. The timber is very strong and tough, being superior in practically all strength grades to English oak. According to tests by the Forest Products Research Laboratory, the bending strength, stiffness, hardness, and shear strength of hornbeam are 20 to 30% higher than those of English oak, and its resistance to splitting 40 to 60% higher.

WORKABILITY. The timber is not unduly difficult to work, although the cross-graining makes care necessary, especially when the timber is fully seasoned. It finishes with a good surface and can also be turned well. For workability it may be compared with the denser qualities of beech.

It takes stain well (being sometimes stained black and used in place of ebony) and may be finished with a high polish.

SIZE and AVAILABILITY. There is a considerable amount of small sized hornbeam in this country, especially mixed with the beech woods, *e.g.*, in the Chilterns. Logs are up to 20 ft. long, although average not more than 8 ft., and up to 15 ins. in diameter (average 10 ins.).

USES. As the timber is very hard and usually obtainable only in comparatively small sizes, it has been used for such purposes as wood screws (*e.g.*, for carpenters' benches), pulleys, bobbins, second-quality tool handles, mallets, skittles, for cogs in certain millwright's work (many old windmills contain numerous hornbeam cogs of all sizes), electric bell-pushes and slats in dynamos. It is occasionally used for piano keys and when stained black used as a substitute for ebony. There is, however, no reason why the timber should not be used for such purposes as smaller dimension stock in furniture and joinery, also for flooring, etc., since it can be stained and polished readily, does not warp nor twist unduly when once seasoned, and has a hard surface.

OTHER TYPES OF HORNBEAM

AMERICAN HORNBEAM

(*Carpinus caroliniana* Walt.)

Similar to the British wood but slightly inferior. It is used for similar purposes.

A number of species are found in China and Japan.

HOP HORNBEAM

(*Ostrya virginiana* K. Koch.)

Although not of the same genus, it is very closely allied. Found in eastern North America, the heartwood is dull brownish, and the timber is heavy, hard and very strong. It is used for tool handles, fencing, etc.

The hop hornbeam of Southern Europe (*Ostrya carpinifolia* Scop.) is similar but of a more reddish colour, and is used for turnery, axles of vehicles, and generally as a substitute for true hornbeam.

LIME

BOTANICAL NAME : *Tilia vulgaris* Hayne

FAMILY : *Tiliaceae*, the Lime or Linden family, consists of trees and shrubs distributed throughout the world, but mostly in the tropics, it includes the jute plant.

OTHER NAMES : Originally only one species of lime, common in Britain, was recognised, *i.e.* *Tilia europaea* L.; now three distinct species are recognised :

1. *Tilia platyphyllos* Scop. (Large-leaved lime.)
2. *Tilia cordata* Mill. (Small-leaved lime.)
3. *Tilia vulgaris* Hayne. (Common lime.)

The common lime is probably a hybrid between the other two, though its origin is uncertain. It is by far the commonest lime in Britain.

N.B. Notes on the other species will be found on page 53.

DISTRIBUTION. Common lime has a wide distribution in Central and Southern Europe, and was introduced probably during the 17th century, although some authorities give the Romans the credit.

THE TREE. *T. vulgaris* attains large sizes under suitable conditions, sometimes reaching 130 ft. in height and with a diameter of up to 4 ft. It is generally grown as a park, avenue or street tree, and, for this reason, long, clean boles are seldom found. Also many of the trunks bear large burrs which reduce the value of the timber. When trees are grown in close forest stems may be obtained measuring 50 ft. to the first branch.

Lime is interesting in that it is one of the few timber trees grown in this country which have flowers with conspicuous petals and a strong, sweet scent ; pollination is carried out mainly by bees and not wind (as with most trees). The leaves are about 3 ins. across.

Soil and Situation. Lime is fairly accommodating as to soil and will thrive on most types that are not too poor and dry ; it succeeds best, and attains its best dimensions on a fresh, fertile loam.

Sylvicultural Characteristics. It is fairly frost-hardy and will bear a light shade, especially as coppice. It will also endure a smoky atmosphere, and so is widely planted in towns, where it is usually pollarded heavily, with a consequence that masses of epicormic branches are produced, burrs form, and the whole tree becomes disfigured.

The life of lime is exceptionally long, it may be 500 years or more ; old trees are very often hollow.

The timber has never been regarded as sufficiently valuable for the tree to be grown in woods, and it is generally found only used for amenity purposes in this country.

The leaves may be used for cattle fodder, and are highly esteemed in some countries for this purpose.

Cultivation. Seed is borne annually after the tree reaches about 35 years old, but very often the seed does not ripen, and lime is usually propagated by layering.

Lime coppices easily, and produces good straight shoots which are useful for binding birch besoms (for which purpose the bark only is used) and supplying handles for them. Owing to the stringy nature of the bark, coppice shoots are seldom damaged by rabbits.

Use of Bast. From the inner bark is taken the ' bast,' from which were made the well-known mats imported from Russia (where the tree is grown on a forest scale for the purpose), and also raffia, twine and rope.

THE TIMBER. White in colour, becoming light yellowish-brown on long exposure to the air, there is no distinction between heartwood and sapwood. It is soft, with a very fine, close and uniform texture, and generally a straight grain.

It is fairly light in weight, being about 35 lbs. a cu. ft. when seasoned. There is little or no figure, except where burrs are present, and even so the figure is not sufficiently attractive to be highly esteemed.

DURABILITY. Lime is not resistant to fungus attack and is also damaged by the Furniture beetle to some extent, although old carvings in lime a century or more old are still found to be free from attack.

Preservatives can easily be forced into lime, and should the timber be used under damp conditions this should always be done. Lime has a very low resistance to fire.

SEASONING. No difficulty is presented in seasoning, although there is some tendency to distort and split when air-dried, and occasionally a superficial stain develops. It is better to use the kiln seasoning method to avoid the above defects. (Kiln Schedule VI recommended.)

STRENGTH. Owing to its softness and lightness, lime has only moderate strength properties. No tests have, as yet, been carried out, so that it is not possible to give an accurate comparison with other timbers.

WORKABILITY. The timber works easily both with hand and machine tools ; sharp, thin cutting edges are necessary, owing to the softness of the wood, the surface of which will become roughened if this point is not watched. It is one of the best woods for carving, and much of the

famous work of Grinling Gibbons and his school was executed in lime.

The wood also turns well, takes nails and screws without splitting, can be glued without trouble and stains and polishes well.

SIZE and AVAILABILITY. Logs are seldom more than 20 ft. long (average 10 ft.) and up to 24 ins. in diameter (average 12 ins.).

Supplies are rather limited, most of the trunks available are disfigured by burrs and pin-knots (due to numerous small twigs springing from the trunk).

USES. Lime is undoubtedly the best home-grown wood for carving (it should always be used thoroughly seasoned) and it has been used for this purpose for many years.

It was formerly in great demand for musical instruments, including sounding boards and keys of pianos, harps, etc., but is now comparatively little used, although selected butts are still used by the piano trade. Probably the most important modern use is in cabinet works, especially for the framework of furniture which is to be covered with fabrics.

As the wood may be scrubbed to a clean, white appearance, it is used for kitchen and dairy utensils, and in butchers' shops.

At one time one of the principal turned articles from lime was druggists' boxes, but recently there has been an increase in the use of lime for spools and other industrial turned goods.

Other uses include artificial limbs, brush backs, toys, frames for bee-hives, match boxes and hat blocks. Leather workers value it to cut on as it is sufficiently soft not to blunt their knives.

During the war lime has been used for model aeroplanes for experimental work and similar shaping and modelling work.

OTHER BRITISH LIMES

The timber of the following species of lime is identical in appearance and properties to that of the common lime.

SMALL-LEAVED LIME
(*Tilia cordata* Mill.)

Normally a smaller tree than common lime and will succeed on slightly poorer soil. The leaves are about 2 ins. across.

LARGE-LEAVED LIME
(*Tilia platyphyllos* Scop.)

A very large tree, larger than common lime and usually with a cleaner stem. The leaves are about 4 ins. across.

IMPORTED LIME

BASSWOOD (*Tilia americana* L. = *T. glabra* Vent.). This timber comes from N. America, where it is widely used for such purposes as paper pulp, wooden ware, cheap furniture, plywood and core stock, slack cooperage, wood-wool and excelsior.

It is similar to our home-grown lime, but rather darker in colour and tends to be lighter in weight.

OAK

BOTANICAL and COMMON NAMES: *Quercus Robur* L. (Pedunculate or common oak) and *Quercus petraea* (Matt.) Lieblein (sessile or dur-mast oak). These two species are commonly known as *Q. pedunculata* Ehrh. and *Q. sessiliflora* Salisb. respectively. The two species both produce English oak timber and there is no difference between the timbers. There is much hybridisation between the species and intermediate forms are extremely common. Here both are dealt with together.

FAMILY: *Fagaceae*.

DISTRIBUTION. The two oaks have a very wide distribution throughout nearly all parts of Europe and as far as N. Africa, Asia Minor, and the Caucasus. The sessile oak has a somewhat more restricted range than common oak, but it forms a higher percentage of the oaks in Germany than in Britain.

THE TREE. The oak is the best known and commonest tree in most parts of Britain. The sessile oak is the more common species in Wales.

The trees vary in height from 50 ft. to 90 ft. according to the locality, and may have a diameter of up to 5 ft. Many individual and specimen trees have a very much greater diameter, but these are often rotten in the centre. When grown in the open, oaks invariably have a short bole and an extremely large spreading crown. Clear boles of more than 30 ft. are rare. This type of tree was of great value for ship-building when our battleships were built entirely of oak. Kent, Sussex and Surrey supplied vast quantities of timber for the British Navy, so much so that the first forest laws passed in this country insisted that in oak woodlands a certain number of standard trees were to be left to the acre, to produce knees and bends for the Navy.

Sessile oak has a more upright habit and less tendency to produce huge, horizontal branches than common oak; it is also said to be the faster growing, and may attain slightly greater heights.

These two trees are easily identified by the fact that the pedunculate oak has its acorns borne on a long stem (botanically known as the 'peduncle') whilst the sessile oak has the acorns borne directly on the twigs.

Soil and Situation. Common oak requires a deep, fresh and fertile soil to attain its best growth; it will grow well on heavy clays and even on sandy soils if they are moist and sufficiently deep. It needs warmth, and prefers a southern aspect, although it may be found at elevations of 1,500 ft.

The sessile oak will be content with poorer and drier soils, and is more common at high elevations.

It will be found, especially in Central Europe, that in the valleys with rich alluvial soil the predominating species is the common oak, and a clear line of demarcation can often be distinguished when the sessile oak takes the place of the pedunculate at altitudes where the soil is poorer.

Sylvicultural Characteristics. Oak is one of the most wind-firm of our trees. Being a light-demanding tree, the side branches always reach massive development when given full overhead light. This type of oak tree no longer yields valuable timber, and, therefore, oaks are grown close together in woodlands to restrict the amount of light, so that one tree struggling for existence against the other, in competition to be in the upper storey of the forest, reduces the number of side branches and produces a straight cylindrical bole. Foresters help to maintain the correct amount of light to produce this type of growth by periodical thinning, and this system is quite simply worked by cutting out the weak, crooked and suppressed trees to help the strong to form the final crop. Thus an oak woodland to-day, grown on proper sylvicultural systems will yield much longer, straighter, and cleaner stems, and are therefore of greater value when converted into timber.

It tends to suffer from late frosts, but comes into leaf so late that it generally escapes injury. Sessile oak is somewhat hardier than the pedunculate.

Oak is a fairly rapid grower and lives to a great age, it matures, however, at about 150 to 200 years, and should then be felled.

Cultivation. Oak is usually raised from seed, but care must be taken to prevent the acorns being eaten by vermin or birds. If young trees are used for planting out 1-year seedings are generally best.

It is best grown in close forest with a mixture of a shade-bearing tree, such as beech. It will coppice readily, but there is now little or no sale for oak coppice. At one time this form of treatment was widely practised to produce bark for tannin.

Diseases. Oak is apt to be attacked by a large number of diseases, the commonest are: the *oak mildew* and the *oak-leaf roller-moth* (which sometimes defoliates whole woods).

THE TIMBER. Oak is probably the best known of all woods, and is one of the most useful hardwoods in the world; it is possibly used more extensively and for a greater number of purposes in this country than any other wood. The sapwood is pale brown and sharply distinct from the heartwood, which varies from golden-brown to red-brown or dark, warm brown. Quarter-sawn (radial) surfaces show the characteristic silver grain (also known as 'flame,' 'chink' or 'flower') caused by the very broad rays (see description of anatomy on p. 24).

An attractive figure is seen on plain-sawn surfaces, this is due to the difference in size of vessels in spring and summer wood.

The wood is hard, coarse in texture and generally straight grained. Its properties vary considerably with the locality of the tree and the rate of growth; slow-grown wood being usually milder and lighter in weight and weaker than fast-grown oak. The weight varies from 40 to 50 lbs. a cu. ft. when seasoned, but on an average is about 45 lbs.

There is no essential difference between the timbers of common and sessile oak, although it is sometimes held that the latter is milder to work and less durable.

Oak has the disadvantage of being very corrosive to metals, especially iron, and it should never be used so as to be in permanent contact with metal. It is for this reason that teak has largely superseded oak in naval ship construction.

Brown Oak. Sometimes oak is coloured an exceptionally deep, rich brown, and the colour may run off into streaks, this is the result of the early stages of an attack of the 'Beef-steak fungus' (*Fistulina hepatica*). Fortunately, brown oak is almost as strong as normal oak and the growth of the fungus is stopped by seasoning.

DURABILITY. The heartwood of oak is extremely durable, both for exterior and interior work, and many examples of its durability can be found in this country. Many of our famous cathedrals and churches are excellent examples of roof construction in British oak. Trouble has, however, sometimes arisen from lack of foresight by allowing beams to be placed into position with a certain amount of sapwood (which is not durable). This sapwood has been attacked by the Death Watch beetle, and oak has been considered a non-durable wood through this cause. Under suitable conditions the heartwood may also be attacked by this beetle. If these various timbers had been examined by experts periodically the attacks could have been readily detected

before the damage became serious, and treatment would have cured the trouble.

The Lyctus beetle, which was introduced into this country from America, has also been causing a certain amount of damage to the sapwood of oak and other hardwoods. Parcels of oak which are going into buildings, if kiln dried, would be free from Lyctus beetle, as this process of seasoning kills the grubs.

The Furniture beetle often attacks the sapwood; logs and unseasoned planks may be damaged by Pin-hole borers.

The sapwood of oak can easily be impregnated with a wood preservative, but the heartwood is extremely resistant; in fact, it is almost impossible to obtain any penetration.

Oak is very fire-resistant.

SEASONING. Oak is a difficult timber to season, as it is very prone to split and check. It air-seasons slowly, and no effort should be made to speed up the process; in fact, small piling sticks ($\frac{1}{2}$ in. square) should be used (especially if the timber is piled in dry weather), and the ends of the logs or boards protected with a waterproof paint (see page 16, for a suitable formula), or metal cleats.

The timber is best converted as soon as possible after felling (which should be carried out in the winter) and immediately put into stick. Where possible logs should be cut on the quarter, as plain-sawn boards tend to 'cup' badly. When sawn 'through and through' (*i.e.*, plain sawn), pieces from the same log should be piled together.

When kiln seasoning the humidity should be kept as high as possible, and the temperature low, until the moisture content has fallen to about 20%. (Kiln Schedule III recommended.)

To obtain the best results oak is usually air-seasoned for some considerable period (often many years) before a final kilning.

STRENGTH. The strength of oak is proverbial; although it is very tough, hard and strong, it is not the strongest of British timbers; beech has higher values in most categories, for instance.

It is used, however, as a standard with which to compare other species.

WORKABILITY. The timber varies from hard to comparatively mild, and this naturally makes a considerable difference in the working qualities. However, when seasoned, it can be worked very readily to an exceptionally fine finish. Tools need to be sharp and of good quality in order to deal with the harder types of oak, and to avoid undue 'picking up' on cross-grained material and where knots and other defects are present.

It may be cut into veneers, especially by slicing, without difficulty, and takes glue well. It holds screws and nails firmly; can be stained and polished easily, and also lends itself to such treatment as fuming.

SIZE and AVAILABILITY. Oak varies very considerably in size and quality; large, sound trunks, free from branches are very valuable and somewhat rare. Lengths of up to 60 ft. are available, but the average is about 12 ft.; diameters are up to 60 ins., but average about 18 ins.

There is a considerable amount of oak in Britain, but heavy inroads have been made both during the present war and in 1914–18. Although it is unlikely that there will be a shortage, the best quality timber will probably become very scarce.

USES. Oak is used for a vast variety of purposes, the following list includes the most important of these:

House Building:
- Flooring (strip and block).
- Panelling.
- Staircases.
- Doors.
- Cills and other high-class joinery.
- Roof shingles.
- Shop fittings.

Heavy Construction:
- Roof beams and trusses.
- Dock construction.
- Warehouse construction.
- Lock gates.

Railway:
- Wagon framing and scantlings.
- Carriage framing.
- Keys and trenails.

Ships and Boats:
- Ribs and framing for barges, yachts, lifeboats, etc.

Furniture:
- Practically all kinds.

Cooperage:
- Barrel staves.

Estate work:
- Fencing: post and rail, and cleft pale.
- Gates of all types.

Miscellaneous:
- Pit timber.
- Veneers.
- Ladder rungs.
- Coffin boards.
- Mouldings.
- Turnery.
- Cart frames and shafts.
- Wheelwrights' work.

Carving.
Motor vehicle construction.
Machine beds for heavy engineering.
Battery containers.

HOLM OAK (EVERGREEN OAK or ILEX)

(*Quercus Ilex* L.)

Grown purely for ornamental purposes, as it forms a huge crown which often sweeps to the ground. Under good conditions it reaches 70–80 ft. high, but the branches usually begin low down and spoil the trunk for timber. It needs a sheltered situation and a deep, open, and fairly dry soil; a heavy clay is unsuitable. It flourishes at the seaside. The evergreen leaves are small, dark green, and resemble holly leaves. A native of the Mediterranean region, it has been cultivated in Britain since the 16th century.

THE TIMBER is pale brown to reddish in colour, with little difference between heartwood and sapwood; the silver grain is very broad and conspicuous. It is exceptionally hard and heavy, weighing between 50 and 60 lbs. a cu. ft. when seasoned.

DURABILITY. Resistant to decay, liable to attack by *Lyctus* beetles.

SEASONING. Difficult to season, very prone to shake and warp.

STRENGTH. No tests have been carried out, but it has proved itself to be very strong in practice.

WORKABILITY. Somewhat difficult to work, especially with hand tools; it tends to 'pick up' in planing, and a low cutting angle (of 20 degrees) is desirable. A good finish can, however, be obtained with care, and the timber will polish well; it also takes glue satisfactorily.

SIZES and AVAILABILITY. Very small supplies are available and logs are usually short, although they may be of good diameter.

USES. Mostly used for estate purposes, *e.g.*, gates, fences, etc. It would be suitable for decorative work on account of its good figure if difficulties of working and seasoning are overcome.

TURKEY OAK

(*Quercus Cerris* L.)

A much taller tree than common oak, sometimes reaching 120 ft. in height, it prefers a sheltered situation and a southern aspect, and a dry, loamy soil. It grows faster than common oak, and with a less spreading crown, but is liable to be injured by wind. A native of Southern Europe, it was introduced in 1735 and is mainly grown for ornament, and also in hedgerows.

THE TIMBER. Is much inferior to that of common oak. The sapwood is very wide, the heartwood is of a rather dark reddish colour. It is hard and heavier than common oak: 50 to 55 lbs. a cu. ft. when seasoned.

DURABILITY. Even the heartwood is not resistant to decay, and green timber is liable to attack by pinhole borers. Lyctus beetles frequently attack dry sapwood. Whilst the sapwood will absorb preservatives readily, the heartwood is very resistant, and cannot be treated satisfactorily, even under pressure.

SEASONING. Difficult to season, usually warping and shaking.

STRENGTH. No tests have been made, but the timber is inferior in strength to common oak.

WORKABILITY. Saws cleanly from the log and works fairly easily to a good finish. It may be bent readily, being one of the best of home-grown timbers in this way. It tends to split on nailing.

SIZE and AVAILABILITY. Supplies are limited as the tree has not been grown on a large scale; however, fairly frequent logs of good size are obtainable.

USES. For poorer quality furniture and interior decoration. It is unsuitable for outside purposes unless treated with a preservative.

IMPORTED OAK

CONTINENTAL or EUROPEAN OAK. A considerable quantity of oak is normally imported from Central Europe; it is derived from the same species as English oak. The varieties are described according to the countries of origin, *e.g.*, Austrian oak, Slavonian oak, Polish oak, Volhynian oak, etc. It should be clearly understood that these names cannot be considered entirely satisfactory, for to state where Polish oak finishes and Austrian oak commences is impossible, owing to the varying political boundaries, for man makes boundaries, but the distribution of trees is more or less maintained.

Certain types, particularly Austrian or Slavonian oak, were generally preferred to English oak for joinery and furniture, as they tended to be milder to work.

AMERICAN WHITE OAK (*Quercus alba* L. and spp.). American oaks are divided into two main groups: (1) White oaks, and (2) Red oaks; each comprises a number of species which are very similar in their properties and are mixed more or less indiscriminately. Black oak (*Q. velutina* Lam.) is classed in the Red oaks group; it is one of the heaviest of the red oaks and is hard, strong and light reddish-brown.

The heartwood of white oak is usually pale,

greyish-brown, and sapwood is almost white. The timber is strong and durable (though slightly inferior in both qualities to English oak) and usually straight-grained. It is widely used in this country for most of the purposes for which English oak is used.

AMERICAN RED OAK (*Quercus borealis* Michx. f. and spp.). The heartwood has a distinct reddish tinge and it is rather coarser in texture than white oak, not so durable and somewhat difficult to work. Being porous it is not suitable for tight cooperage, but may be used for furniture and interior joinery.

JAPANESE OAK (*Quercus grosseserrata* Blume and spp.). Before the war considerable quantities were imported as the timber was usually very slowly grown and so very mild and easy to work, and in favour for furniture and interior work. It is not very durable and should not be used, unprotected, in the open. The silver grain is smaller than in English oak.

OTHER TIMBERS KNOWN AS OAK. Owing to the popularity of oak, a number of timbers botanically unrelated to true oak (*Quercus*) have been given the name for commercial reasons. Some of the better known of these are: Australian silky oak (*Cardwellia sublimis* F.V.M. and *Grevillea robusta* A. Cunn.), Tasmanian oak (*Eucalyptus obliqua* L'Hérit.), the Shee oaks (*Casuarina* spp.) and African oak (*Oldfieldia africana* Bth. et Hook. f.).

PLANE

BOTANICAL NAME: *Platanus acerifolia* Willd.

FAMILY: *Platanaceae*, which consists of only the one genus, *Platanus*.

COMMON NAMES: London Plane or Lacewood (this name originated in America and is used for stock that is cut dead on the quarter and displaying the very pronounced silver grain).

In Scotland the name 'Plane' is given to the English sycamore (*Acer pseudoplatanus*).

DISTRIBUTION. The origin of the London plane is unknown, and it has never been found growing wild. It is believed to be a hybrid between the Oriental plane (*P. orientalis* L.) and the Western plane (*P. occidentalis* L.). It is believed to have been first recognised in England about 1670.

It now has a fairly wide range throughout the more temperate parts of Europe.

THE TREE. It forms a very large tree, often growing to more than 100 ft. in height, with a diameter of 3–4 ft., occasionally up to 6 ft. When grown in the open and not subjected to lopping it forms a huge open crown, but often with a good length of clean bole.

Plane is never grown as a forest tree, but it has been widely planted in London and other big cities because it is one of the best trees known for withstanding a smoky atmosphere. It is by far the commonest plane growing in this country. The smooth bark, which peels off in large flakes, leaving patches of new yellow-coloured bark exposed, is familiar to everyone.

The leaves of plane are large and five lobed, the lobes being sharply pointed at the tops; the stalks of the leaves are characteristic in that the swollen bases completely enclose the buds.

Soil and Situation. Plane is not very demanding as to soil, and will thrive on most types that are not too heavy and do not contain a large percentage of lime. It is a light demander and is somewhat sensitive to frost, and does better in a fairly sheltered situation.

Cultivation. Plane may be raised from seed, but is most easily propagated by means of cuttings from one or two-year-old twigs, which root as easily as poplar 'sets.' If grown for timber a rotation of 100–150 years would probably be most economic.

THE TIMBER. The colour varies from pale-yellow (sapwood) to light red and even dark brown—in old trees. There is no distinct line between the heartwood and the sapwood, although the latter is generally lighter in colour. Some trees, particularly very old ones, have an irregular darker area in the heart, sometimes with blackish lines. The timber is very similar to beech both in colour and texture, but can easily be distinguished by the broad reddish rays which are very conspicuous on the quarter-sawn surface, especially as they show up against the pale background (when cut in this manner plane is known as *Lacewood*).

Plane is fairly hard, has a fine uniform texture with a satiny sheen on finished surfaces. It varies in weight from 30–45 lbs. a cu. ft., the average is about 40 lbs. per cu. ft. when seasoned.

There is no doubt that plane is one of the most beautiful of English woods.

DURABILITY. It is not particularly resistant to decay, and is liable to attack by the Furniture beetle.

SEASONING. The timber seasons easily either in kilns or in the open; little degrade occurs except some warping, especially in cross-grained logs. (Kiln Schedule V suitable.)

STRENGTH. It is fairly tough and elastic, but the limited tests carried out by the Forest Products Research Laboratory on home-grown plane show that it is slightly weaker than beech

in all strength categories. It has, however, higher values for hardness, shearing strength and resistance to splitting than oak.

WORKABILITY. The log converts fairly easily, with some tendency to bind on the saw. It works easily with all hand and machine tools; occasionally there is a slight tendency for saws to bind. It turns and veneers as well as beech, takes an excellent finish and may be polished and glued easily.

SIZE and AVAILABILITY. As plane is usually grown for amenity purposes only there is a comparatively small amount of timber available, but the value of the timber would warrant the planting of trees for timber on a much wider scale.

Logs are up to 30 ft. long (average 12 ft.) and with a maximum usable diameter of 48 inches.

USES. Plane is mainly used in this country for decorative work; inlaying, fancy goods, cross-bending, etc. Veneers are used more than the solid wood.

In Persia, where the tree is widely grown, plane is used almost exclusively for furniture, joinery, doors, etc.; it is also extensively used in France.

The timber could well be used for more purposes than is the case, both as veneer and in the solid (for decorative flooring, furniture, etc.).

OTHER SPECIES OF PLANE

ORIENTAL (or EASTERN) PLANE
(*Platanus orientalis* L.)

One of the longest lived of all European trees, and attaining large dimensions; in Britain reaching to 100 ft. in height and 3–6 ft. in diameter.

It is native of S.E. Europe and Asia Minor, being introduced into England in the sixteenth century. It is not frequent in this country, but is sometimes grown as an ornamental tree.

The timber is practically identical to that of the London plane; small quantities were sometimes imported from the Continent.

WESTERN PLANE
(*Platanus occidentalis* L.)

Also known as American plane and, in America, as Buttonwood or Sycamore. (*N.B.* In America, as in Scotland, species of the genus *Platanus* are usually known as Sycamores, a name kept for *Acer pseudoplatanus* L. in England.)

It is a very large tree, attaining diameters in America of 8 ft. and up (maximum known is 14 ft.). This species is often confused with the London plane; actually there are practically no trees of greater than pole size growing in this country, as it is extremely frost tender and seldom survives more than a few years.

It is found in the southern and eastern United States and as far north as southern Ontario.

The timber is very similar to that of the London plane.

Two other species are abundant in certain parts of America, but are not of timber value; one is the ARIZONA SYCAMORE (or Plane) *Platanus Wrightii* S. Watts, and the other the CALIFORNIA SYCAMORE, *P. racemosa* Nutt.

POPLAR

BOTANICAL NAME: *Populus* spp.

FAMILY: *Salicaceae*, this also includes the willows (*Salix* spp.) from which it takes its name.

OTHER NAMES: There are a large number of different species of poplars, and, since the tree easily forms hybrids, the classification is still further complicated. However, the poplars naturally fall into four groups:

Black Poplars. These include *P. nigra* L. (Black Poplar); *P. canadensis* var. *regenerata* (Schneid.) Rehd. (Black Italian Poplar); and *P. canadensis* var. *serotina* (Hartig.) Rehd. and *P. robusta*, C. K. Schneider.

Balsam Poplars. These are so called because of the fragrant scent of balsam given off by leaves and buds. They include *P. Tacamahaca* Mill., *P. trichocarpa* Torr. and Gray ex Hook., and *P. generosa*, Henry.

White Poplars. These comprise *P. alba* L. (White Poplar or Abele) and *P. canescens* Sm. (Grey Poplar).

Aspen. *P. tremula* L.

In the timber trade the timber is usually marketed as poplar, without any differentiation, but it may be divided into the above groups.

Individually the most important species are: black Italian poplar, black poplar, grey poplar, white poplar and aspen.

DISTRIBUTION. Poplars have a wide distribution in the Northern Hemisphere outside the tropics, but stretching as far as the sub-arctic and sub-tropical zones, some species even under arid conditions. Several species are native of Britain, and all the species named above grow in this country.

Aspen is considered to have a wider distribution than any other tree, extending from Lapland to Africa and Ireland to Japan.

THE TREES. *Black Italian Poplar* (*P. canadensis* var. *serotina* (Hartig.) Rehd. [= *P. serotina Hartig.*). Up to 110 ft. in height, with the trunk clear of branches for 50–60 ft.; diameter 3–5 ft. One of the most widely planted of the poplars as it produces clean timber and

grows fast (a 30-year-old tree may have a trunk containing 90 cu. ft.); a short rotation of 20–50 years would probably be most economic.

Black Poplar (*P. nigra* L.). About the same size as black Italian poplar, or slightly smaller. It is very fast grown and may attain 80 ft. in 30 years. A rotation of 50–80 years is suitable. The well-known Lombardy poplar is a variety of the black poplar, but the abundance of branches persisting along the whole length of the trunk render it almost useless for timber.

Grey Poplar (*P. canescens* Sm.). Up to 100 ft. in height and 4 ft. in diameter, often with a long, clean trunk.

White Poplar (*P. alba* L.). A smaller tree, up to 60 ft. high and about 2 ft. in diameter. It is comparatively rare.

Aspen (*P. tremula* L.). The smallest of the poplars, seldom reaching more than 50 ft. high or 2 ft. in diameter. Although native to Britain it is not common; it is more frequently found in the north than the south, and some plantations have been made in Scotland to furnish the match industry with timber, for which purpose a rotation of 25–50 years would be best. It may be raised from seed.

Soil and Situation. As a whole poplars prefer moist soils and fairly sheltered situations to attain their best development. The black poplars do best on good, deep soils, or, if on poorer types, they should be planted on slopes where there is plenty of moisture. White poplars thrive best on moist, sandy loams, but will succeed even on clay. Aspen will do well on most soils that are reasonably moist; it will grow at higher elevations than any other poplar.

Sylvicultural Characteristics. Poplars generally are hardy, light-demanding trees which grow rapidly. They are wind-firm, and so valuable trees for shelter belts (the Lombardy poplar makes an excellent shelter for orchards) and can also be used to mix with young conifers as 'nurse' trees.

It would be of great benefit to the country if landowners and farmers would grow small clumps or plantations of the best types of poplars. The trees can be grown from large cuttings (up to 6 ft. long, but best about 18 ins.) and easily pruned as they grow; by these means a large amount of good quality timber could quickly be produced.

Cultivation. Partly owing to the fact that poplars are diœcious (*i.e.*, have male and female flowers on separate trees), they do not produce fertile seed very freely, indeed, in some species only trees of one sex are known.

Cultivation is, however, very easy if large cuttings are used (see previous paragraph).

Diseases. The timber of standing trees is sometimes damaged by the boring of the Goat Moth caterpillar (*Cossus cossus*), and also by the large poplar Longicorn beetle (*Saperda carcharias*) and the small Longicorn (*Saperda populnea*), which bores in the twigs.

Varieties. As ornamental trees poplars are amongst the most useful of trees. The narrow, fastigiate types such as the Lombardy poplar and *Populus Rasumowskyana* Schneid., can be used to block out the view of factory chimneys, for instance. Other useful and beautiful poplars are *P. robusta* C. K. Schneider, *P. Petrowskyana* Schneid., and *P. yunnanensis* Dode.

THE TIMBER. The timber of the various poplars varies somewhat, but the general character of the wood is as follows: soft, light—varying from 23–34 lbs. per cu. ft. seasoned (Black Italian poplar is about 28 lbs.), odourless, woolly, texture fine and even, straight grained. The colour varies from white to pale brown, grey or light red, frequently streaked; the sapwood and heartwood usually show no distinct difference, although grey poplar usually has a distinct golden-brown heartwood (and also sometimes a roey figure). Dead knots are often loose and surrounded by rotten wood.

Burrs are common in some species, *e.g.*, black poplar, and poplar wood showing figure due to the marks of mistletoe sinkers is often known as Abele wood.

DURABILITY. None of the poplars is at all durable, and will rot quickly in contact with the ground. The heartwood of both black Italian and grey poplars is difficult to impregnate at all evenly with creosote, but the sapwood offers little resistance.

The timber may be damaged in the standing tree by Longicorn beetles. Converted timber is, however, immune from attack by Lyctus beetle, though not from Furniture beetle.

SEASONING. There is usually little trouble in either air-seasoning or kilning, though careful stacking is necessary to avoid warping and discoloration; undue temperatures tend to split the knots (especially in black Italian poplar). (Kiln Schedule V suggested.)

STRENGTH. Although soft, poplar is fairly strong for its weight.

Black Italian Poplar. The timber is tough, and (according to the F.P.R.L.) only 20–30% inferior to home-grown oak in toughness, stiffness, bending strength, crushing strength along the grain, and resistance to splitting.

Grey Poplar. Is slightly stronger than the black Italian.

Aspen has good strength properties, and its toughness makes it excellent for matches and match boxes, as it does not fracture easily when bent (as in striking a match or making a match-box).

WORKABILITY. Most poplars, owing to their woolly character, are difficult to saw and sometimes tend to bind; the black and black Italian poplars are better in this respect and saw fairly cleanly. Sharp tools with thin edges are necessary to obtain a good finish. They split easily and take glue, paint and polish well; stain sometimes tends to take patchily. Nails hold well, and clean timber veneers well (especially aspen). Of all the poplars the black Italian poplar is the best for working.

SIZE and AVAILABILITY. There is not a large amount of poplar grown in the U.K., but of recent years a number of plantations have been made, and these should prove the value of planting this type of tree on a much larger scale. Owing to the comparative ignorance of the virtues of poplar the limited supplies in the past have been sufficient to meet the demand.

Black Italian Poplar is most abundant, and logs are occasionally up to 60 ft. long, but only average about 15 ft., and with a maximum diameter of 60 ins. (average 24 ins.).

White Poplar is much rarer and smaller; logs up to 30 ft. long (average 12 ft.) and 24 ins. in diameter (average 12 ins.).

Aspen is also rather scarce and logs generally very small, the maximum length being 20 ft. (average 10 ft.) and seldom more than 12 ins. in diameter (average 6 ins.).

USES. Poplar is an extremely useful wood for many purposes; its quality of resisting indenting and splintering and rough usage generally makes it excellent for the bottoms of carts and lorries and for brake blocks. Most poplars, and aspen especially, are ideal for match making and matchboxes, and can also be used for wood pulp. Other uses include:

Floors of kilns in certain factories, etc., tubs, box boards, chip baskets for fruit and vegetables, packing cases, toys, plywood, hat blocks, wood wool (it produces better quality wood wool than whitewood or basswood), pencils.

During the war poplar veneer has been manufactured for aircraft construction, and its use as commercial plywood has increased.

IMPORTED TYPES OF POPLAR

COTTONWOOD

Most poplars in America are called cottonwood (owing to the seeds being covered in a cotton-like down). There are three main commercial species, the timbers of which are mixed more or less indiscriminately and sold under the general heading of cottonwood. It is imported mainly as plywood, for boxes and other low-grade purposes, and also in the solid for certain classes of turnery. The individual species are as follows:

EASTERN COTTONWOOD (*Populus deltoides* Marsh.) is found scattered throughout eastern U.S.A. and Canada. It reaches 70–85 ft. in height and 2–3 ft. in diameter.

SWAMP COTTONWOOD (*Populus heterophylla* L.) found in the South Atlantic and Gulf Coast regions and the Mississippi Valley. A tall tree, up to 100 ft. high, and a very fast grower.

BLACK COTTONWOOD (*Populus trichocarpa* Torr. and Gray ex Hook.) is 'the largest deciduous tree of the Pacific Coast and ranges from Southern Alaska to Southern California' (103). It is frequently over 100 ft. high and 4 ft. in diameter, occasionally up to 6 ft.

BALSAM POPLAR (*Populus Tacamahaca* L.). Found mostly in Eastern Canada, it is a large tree, sometimes 6 ft. in diameter and up to 100 ft. high (the average is about 60–70 ft.).

The timber is very similar to the cottonwoods and used for similar purposes.

AMERICAN ASPEN (*Populus tremuloides* Michx.). Found throughout the north-eastern region of U.S.A., and considerable areas in Canada. It is similar to the European aspen and in America mainly used for paper, also for matches, food containers, etc. Very little is imported.

YELLOW POPLAR is the common American name for *Liriodendron Tulipifera* L., the timber of which is better known in this country as Canary or American whitewood. The tree is occasionally grown for ornamental purposes in Britain, and is known as the Tulip tree (see pp. 76–77).

SYCAMORE

BOTANICAL NAME: *Acer pseudoplatanus* L.

FAMILY: *Aceraceae;* trees and shrubs mostly inhabiting the temperate regions of the northern hemisphere. The main genus is *Acer*, which includes all the true maples.

COMMON NAMES: Plane (in Scotland), Great Maple, False Plane, Sycamore Plane. When treated with a through-and-through dyeing process which colours the wood grey it is sometimes known as 'Harewood.' There is some confusion over the names, due to the resemblance of sycamore to plane. Thus, in America, all the trees of the genus *Acer* are called maples and all those of the genus *Platanus* sycamore. When

Americans speak of ' sycamore ' they refer to *Platanus occidentalis* L.

DISTRIBUTION. Sycamore has a wide distribution in the temperate regions of Europe and as far as Western Asia, where it is native. It is believed to have been introduced during the fifteenth century and has so established itself that it is found in practically all parts of Britain.

THE TREE. Sycamore varies considerably in size, but under favourable conditions forms a tree of the largest size ; it may exceed 100 ft. in height and 6 ft. in diameter. Trees with clear boles of 50 ft. were not uncommon a few years ago, but such large trees have become limited in number owing to their popularity for veneer cutting.

When grown in the open sycamore, like oak, forms a huge crown with large horizontal branches and a short thick trunk.

It is one of the commonest trees in Britain, being found in hedgerows, woods, parks, etc.

Soil and Situation. It thrives best on a deep, fertile and moist soil, in which there is some lime, but if sufficiently deep the tree will grow well on most kinds of soil.

Hills and exposed situations are well suited to sycamore, and it will succeed near the sea under conditions that would be fatal to almost all other deciduous trees.

Sylvicultural Characteristics. Owing to its deeply penetrating tap-root sycamore is one of the most wind-firm of all our trees and forms an ideal shelter for other species. It will tolerate a certain amount of shade, especially as coppice, but needs full light for its best development. It is somewhat tender to late frosts.

A rapid grower, sycamore reaches maturity at 80–100 years ; although much older trees will be found, it is not good practice to allow trees to grow much beyond maturity.

Cultivation. Seed production is prolific and begins early (at about 25 years old in open grown trees). Sycamore is raised almost entirely from seed, which should be sown early as it tends to lose its germinative powers if kept. It also regenerates itself freely. 1 yr. 2 yr. transplants are best for planting out in the forest area.

It is best grown in mixed woodland, and sycamore, ash and larch is a profitable mixture on suitable soil (especially good ash soil—see page 39). It may also be used to underplant larch, which throws only a light shade.

Sycamore, will coppice readily, but the small stems so produced have little commercial value.

Diseases. Frequently the leaves are disfigured by the presence of numbers of black spots, due to a disease known as ' Tar spot ' (caused by the fungus *Rhytisma acerinum*).

Varieties. A large number of varieties have been produced, mostly of types with different coloured or variegated foliage, *e.g.*, var. *variegatum*, with leaves blotched with white ; var. *brilliantissimum*, with leaves pinkish on unfolding ; var. *purpureum*, with leaves rich purple beneath, etc.

THE TIMBER. An attractive creamy-white to yellowish-white timber, which tends to darken on exposure to a pale golden brown. Sycamore should be felled in winter and converted as soon as possible in order to preserve the light colour and avoid staining. There is no distinct heartwood, but logs may sometimes be slightly brown in the centre.

It is usually straight-grained with a fine, uniform texture, fairly hard, even wearing and with a silky lustre, especially observable on quarter-cut surfaces.

Moderately heavy, the wood weighs from 35–45 lbs. per cu. ft. when seasoned (average about 40 lbs.).

Curly and wavy grain sycamore is sometimes found giving an attractive ripple which is highly esteemed by veneer cutters.

Sycamore is sometimes given a special steam treatment, which makes it light yellow-brown in colour ; it is also dyed grey (the wood is coloured right through), when it is known as Harewood or merely as ' grey sycamore.'

DURABILITY. It is not a durable timber, and tends to decay rapidly in the log or if converted wood is left in the open. It is also liable to attack by Furniture beetle, and is occasionally damaged by Lyctus beetles.

It is easy to impregnate with preservatives ; this permeability is taken advantage of by staining the wood to produce ' Harewood '.

Sycamore is very resistant to fire.

SEASONING. The greatest difficulty in seasoning is to prevent staining and discoloration ; this tendency may be overcome by inducing rapid drying immediately after conversion. A golden rule for seasoning sycamore is : ' Never lay two boards together ' ; in warm weather if two boards are in contact for an hour they may turn brownish in colour, and a day in contact is fatal to the original white colour in almost all cases. If the timber is piled in the usual way large stickers (1 in. or larger) should be used ; alternatively the timber may be given a short kilning before piling. Possibly the best method is to ' edge pile ' the boards. In seasoning prime butts the boards are often leant separately against a wall

for a period of a day, or up to a week, after which they can be put in stick or kiln dried.

In the kiln drying of sycamore it is extremely difficult to retain the colour, and great care is necessary. (Kiln Schedule I suggested.)

STRENGTH. A very strong timber, closely resembling oak in strength properties. It bends fairly well in green or dry condition, unless wavy grain is present. It is very difficult to split.

WORKABILITY. It works easily with most tools providing they are sharp. Figured material tends to 'pluck' on planing and a reduced cutting angle is necessary to obviate this. Dry sycamore tends to 'burn' if cutting edges are not kept sharp. Straight-grained timber planes to an excellent finish and is an extremely good turnery wood. It stains, paints and polishes without any difficulty, and is a favourite veneering wood.

SIZE AND AVAILABILITY. Large logs are now comparatively scarce, some logs up to 30 ft. long are obtainable, but the average is about 12 ft. Occasional diameters of 48 ins. are found, but they are mostly about 15 ins. There is still a fair quantity of smaller-sized trees available, and sycamore has been planted more widely in recent years.

USES. Probably the most important modern use of sycamore is for furniture and cabinet work, and for interior decoration. Recent types of design in this work require light colours, a neat figure—if any at all—and large, flat surfaces which are, nevertheless, interesting. Sycamore veneer fulfils all these requirements, and the solid wood is also necessary; different coloured finishes, *i.e.*, harewood and weathered sycamore, are useful adjuncts.

Its clean, white appearance coupled with its ability to be scrubbed without raising the grain unduly, make it ideal for use when cleanliness is essential, *e.g.*, dairy and kitchen utensils (spoons, bread boards, wood dishes, rolling pins, etc.), laundry and bakery tables, rollers in washing machines, mangles and in calico and jute mills.

Sycamore is one of the best home-grown turnery woods, and is widely used for bobbins, reels, rollers, platters, etc.

Amongst the other uses are: brush backs, toys, flooring, butchers' blocks, etc.

Other species of *Acer* are dealt with under the Maples (see pp. 71, 72).

WALNUT

BOTANICAL NAME: *Juglans regia* L.

FAMILY: *Juglandaceae*, or the walnut family, comprises only trees, many of which produce valuable timber; hickory is an important member.

DISTRIBUTION. Walnut has a very wide distribution from most of Europe to Turkey, into Persia, Northern India and China. It forms pure forests in Bosnia and is cultivated in every part of Europe.

It was introduced into England (for its edible nuts) by way of Turkey, Sardinia, Italy and France, probably about the middle of the fifteenth century.

Varying soils, climates and situations produce timber of different density and colour.

THE TREE. Walnut grows up to 100 ft. and sometimes more, but its usual height is 60–80 ft.; diameters usually range from 2–3 ft., but are occasionally up to 6 ft. Since it is chiefly grown for fruit in this country, it is mostly found in the open with a large, low-branching crown. For this reason clean boles of more than 20 ft. are exceptional.

It is not very abundant in England, and two wars have taken their toll of the timber for rifle butts, so that it will probably become even rarer.

Soil and Situation. Walnut needs a deep, rather dry and light loam for its best development and will not succeed on heavy or wet soils. It should be grown in sheltered positions and a cold climate is apt to prevent the nuts from ripening. In fact, north of the Forth the fruit only ripens in exceptionally fine summers.

Sylvicultural Characteristics. The tree is fairly wind-firm, having a very long tap-root—it will not, however, stand an exposed position, as it is tender to late frosts, which sometimes blacken the leaves.

It demands a considerable amount of light and requires plenty of space; when grown in close forest it is best planted in groups with the individual trees wide apart.

Walnut is a rather slow-growing tree, but lives to a great age. It would need a rotation of at least 100 years to produce valuable timber.

Cultivation. Walnut is raised from seed (*i.e.*, the nuts), which should be planted soon after collection, and the seedlings transplanted at one year old (to avoid the tap-root growing too large).

Varieties. Most of the varieties of walnut are cultivated for the qualities of the nuts, *e.g.*, var. *maxima*, having nuts about twice the ordinary size. Possibly the best ornamental variety is var. *laciniata*, which has leaflets deeply lobed.

THE TIMBER. The colour of walnut is somewhat variable, but the basic colour is a greyish background with darker streaks, giving a very

handsome appearance. In certain specimens a reddish-brown streak occurs as well. The irregularity of these streaks gives the figure to the wood. Sapwood is wide and pale straw coloured and distinct from the heartwood. Burrs, crotches and stumps provide highly figured wood which provides valuable veneers.

It is hard, fine and uniform in texture, and moderately heavy, weighing 38–48 lbs. a cu. ft. when seasoned (average about 41 lbs.).

DURABILITY. The heartwood is fairly resistant to decay, but very liable to attack by Furniture beetles; the sapwood is perishable, and often attacked by Lyctus and Furniture beetles.

Using pressure treatment, the sapwood can be completely impregnated with preservative, and considerable penetration can be obtained by the open tank method. The heartwood is very resistant to impregnation.

SEASONING. The timber air-seasons and kilns without serious degrade, though very slowly. It has been stated that walnut shrinks considerably during seasoning, but this is not borne out by tests which show it to shrink less than such woods as beech, oak, elm, etc. (Kiln Schedule V suggested.)

STRENGTH. A hard, tough wood which is resistant to shock, and a good resistance to splitting. The use of walnut for gun stocks and air screws is sufficient proof of its strength properties.

WORKABILITY. It is easy to convert, although young trees are very uneconomical owing to the wide sapwood and frequent defects. Mature trees are better, and the timber is usually closer textured and easier to work. When seasoned the timber, although hard, is fairly easy to work with most hand and machine tools, and takes a fine, smooth finish. It is an excellent carving and turnery wood, and also veneers well.

It glues and polishes well—being frequently French polished.

SIZE and AVAILABILITY. Good-sized logs are rare and fetch high prices. Occasionally logs up to 20 ft. long are found, but the average is about 8 ft.; maximum diameters are about 48 ins., but are seldom more than 16 ins.

USES. Walnut is one of the most popular woods for furniture, being only second to oak in this respect. It first came into general favour at the beginning of the eighteenth century (a period which has been called ' the Walnut Age '), then later it was superseded to a large extent by mahogany, but it came back into favour, and is now more popular than ever. Veneer is mostly used both for furniture and high-class joinery; highly figured material is especially sought after.

There is no serious rival to walnut for *gun-stocks*, as it (*a*) is the right weight for balance, (*b*) takes up the recoil of the gun better than most other woods, (*c*) moves very little when seasoned, (*d*) takes a very smooth surface and is easily turned and carved, (*e*) is hard and strong enough not to be damaged by rough usage.

Other uses include: airscrews, domestic turnery (for which it has recently had a great vogue), *e.g.*, fruit bowls, bread-boards, egg-cups, etc.; tennis and other racquet ' throats '.

It has been used successfully as a wartime substitute for briar for tobacco pipes.

IMPORTED WALNUT

Most of the walnut used in Britain is imported, mainly from France, and also small quantities from Italy, Caucasia and occasionally from Spain. The wood varies, especially in colour and figure, according to the country of origin; the following notes give the general differences:

French Walnut. Probably the largest class of walnut used is French walnut, which is usually rather lighter and more grey in colour than English.

Italian Walnut. Is considered more valuable than French, as the grades imported into Britain are generally well figured and of a good colour. Actually very little walnut had been imported from Italy for some years before the war. The best qualities used to come from Ancona, and the terms Italian and Ancona walnut are now often used to denote any well-figured, dark and streaky walnut.

Circassian Walnut. Represents the better quality timber from Caucasia. Considerable quantities used to be imported, but comparatively little has found its way to the British market for some years.

Spanish Walnut. Small quantities have been imported, and the timber resembles French walnut, but is generally smaller and of poorer quality.

No walnut is imported from India as it all finds a ready local market.

All the above are the products of *Juglans regia* L.

AMERICAN BLACK WALNUT (*Juglans nigra* L.). The timber is similar to *J. regia* in weight and texture, but of a uniform deep purplish-brown colour, varying sometimes to light chocolate-brown. Considerable quantities are normally imported for furniture, turnery, etc.

The tree is native of East and Central U.S.A., and succeeds in the warmer parts of England, and although not common, has been grown since the seventeenth century. Its nuts are valueless

as food, but the tree is very ornamental and grows to a large size.

BUTTERNUT (*Juglans cinerea* L.). The timber is soft and light in weight (about 27 lbs. a cu. ft. when seasoned), the heartwood is light brown in colour with darker markings. Very little is imported, as the black walnut is preferred, but it is used in America for furniture, turnery, mouldings, etc.

The tree, which is native of East N. America, has been cultivated as an ornamental tree in this country for several centuries, but is rarely found.

OTHER TIMBERS NAMED WALNUT. Because walnut is so well known and popular, a large number of woods have been given the name (with a prefixed, description word) which have only a superficial resemblance to the true walnut and no botanical relationship, *e.g.*, Nigerian walnut (*Lovoa Klaineana* Pierre), Queensland walnut (*Endiandra Palmerstonii* Bailey), Satin walnut (*Liquidambar styraciflua* L.), etc.

WILLOW

BOTANICAL and COMMON NAMES. Willows belong to the genus *Salix*, and are closely related to the poplars (*Populus* spp.), in fact, both belong to the same family. *Salix* is a very large genus comprising some 200 species of trees and shrubs, distributed throughout many parts of the world. The various species hybridise easily, so that the classification has become very complicated.

There are several willows in Britain which produce timber ; the most important of these are :

White willow (or Huntingdon willow). *Salix alba* L.

Cricket Bat willow. *Salix alba* var. *coerulea* Koch.

Crack willow. *Salix fragilis* L.

Other less important willows producing timber are :

Bedford willow. *Salix viridis* Fries.

Sallow or Goat willow. *Salix Caprea* L. (this is more often found in a bush-like form).

The names ' Sally ' and ' Withy ' are sometimes used by country people to cover all types of willow.

FAMILY : *Salicaceae*.

DISTRIBUTION. The various species of willow have a wide distribution throughout the world, including Europe, Asia, North and South America, and China. Most of the willow used in this country is, however, home-grown ; there are about 17 species which are native to Britain, and still more which have been introduced and acclimatised.

THE TREE. Willows vary from very small shrubs to large trees. A valuable group is that which produces the osiers from which wicker-work is made. Osiers are thin coppice shoots which are grown in special beds on a very short rotation (usually one year only) and treated like an agricultural crop. There are a number of species used, *e.g.*, *S. viminalis* L. (the common osier), *S. triandra* L. (almond-leaved willow), *S. purpurea* L. (purple osier), etc. Various local names are given to the same species according to the quality of the rods, thus *S. triandra* L. is called Black Mauls, Green Sucklings, Black Hollander and Glibskins.

Some of the tree forms are frequently pollarded, *i.e.*, the crown is cut off the tree at about 7 or 8 ft. from the ground, and the growth of a mass of long, straight shoots from the cut surface is encouraged. The pollard shoots are used for wattle hurdles, stakes, shoring of river banks, etc. They are grown on a longer rotation than osiers. The object of pollarding at a height from the ground is to avoid the young shoots being browsed by horses and cattle.

There is probably more difficulty in the identification of the various species and varieties of willows than almost any other genus found in Britain. This is due to the number of hybrids which have been formed either naturally or artificially.

Willows are interesting in that (like poplars) the male and female flowers are borne on different trees, and in some cases only trees of one sex are known ; these can only be propagated by cuttings.

WHITE WILLOW (*S. alba* L.). Height up to 70 or 80 ft., and diameter up to 4 ft. Unfortunately many trees have been pollarded in the past, and a considerable proportion of these have become hollow and, when in this state, become breeding places for the Death Watch beetle.

CRICKET BAT WILLOW (*S. alba* var. *coerulea* Koch.). Height up to 100 ft. and diameter up to 5 ft. This is probably the most important of the willows—at least from a financial point of view—as it is very fast growing and produces the only timber which is suitable for first-class cricket bats. It is grown from large cuttings or ' sets ' and takes only 10–14 years to reach the optimum size (about 18 ins. diameter) for cricket bats. Sets should only be planted in good soil near moving water (the bank of a stream, at least 3 ft. above water level is ideal) ; 9 or 10 ft. sets, clear of side branches and defects are used. During growth pruning is necessary and bubs are rubbed off, and unwanted branches pruned. Sets should be planted at least 30 ft. by 30 ft. If planted near

stagnant water or under other bad conditions, the wood is frequently damaged by the ' Water-mark ' disease, which also causes a die-back of the tree.

CRACK WILLOW (*S. fragilis* L.). Height up to 90 ft. and diameter up to 5 ft. The tree may easily be identified by drawing the hand sharply along the smaller branches, when the twigs will crack off easily.

BEDFORD WILLOW (*S. viridis* Fries). This is believed to be a hybrid between crack willow and white willow. Height up to 50 ft. and diameter up to 4 ft.

SALLOW or GOAT WILLOW (*S. Caprea* L.). Often in the form of a bush, it is also found as a small tree up to 40 ft. high (usually 15–20 ft.) Twigs bearing the ripe catkins are collected as ' palm ' on Palm Sunday.

Soil and Situation. Nearly all willows (especially the common tree forms) are accommodating as to soil, and only demand plenty of moisture (the goat willow does not even require much moisture), but the soil must be well drained, stagnant water is fatal. Osier beds are usually along riversides and may be on ground too wet for other crops.

Sylvicultural Characteristics. Willows are generally wind-firm, hardy and light-demanding; they are also quick growing and should not be grown on long rotations (not more than 30–40 years for any species). Usually willow is not grown close together, but there is no reason why such species as the white willow should not be planted in this way, either pure or mixed with a few conifers—underplanted with spruce, for instance.

Cultivation. Willow is seldom grown from seed, in fact some species do not produce seed as only the male forms are known. It is easily propagated by cuttings which are stuck in the ground in the winter or early spring. Large ' sets ' (as described in cricket bat willow) may be used for most species.

Varieties and Ornamental Forms. Amongst the hundreds of varieties of willow, some of the most ornamental are :

S. babylonica L. (weeping willow); *S. alba* var. *argentea* Wimm. (silver willow) having foliage of an intense silvery hue; *S. Salamonii* Carr.; *S. pentandra* L. (bay willow) having vivid green foliage.

THE TIMBER. The timber of the various species of willows is very similar in appearance and properties, and variation is more in rate of growth than in any other particular. The sapwood is almost white and the heartwood has a slight brownish tinge. The width of sapwood varies considerably with the species, and the rate of growth; it is very wide in fast-grown white willow and cricket-bat willow. It is soft, usually straight-grained, and has a fine texture. It is light in weight, averaging about 28 lbs. per cu. ft. when seasoned. Cricket-bat willow is somewhat lighter, being 21–26 lbs. per cu. ft. when properly grown for bats (there should be about 7 annual rings to the face of a bat).

There is a strong resemblance between the timbers of willow and poplar.

DURABILITY. The timber is not durable, being very apt to be attacked by fungus and insect pests. The outside of the sapwood is often damaged by Lyctus beetle and wickerwork is prone to attack by Furniture beetle.

The sapwood is easily impregnated with preservatives, even by the open tank method; the heartwood, however, is extremely resistant.

Willow has very low fire-resistant properties.

SEASONING. No difficulty is normally experienced in seasoning willow either in kilns or by air-seasoning. Little degrade takes place and the timber seasons rapidly. (Kiln Schedule VI suggested.)

STRENGTH. There appears to be little difference in the strength properties of the various willows, with the exception of cricket-bat willow, which is somewhat tougher than other species. The timbers are very tough (cricket-bat willow being only about 15% inferior to ash in this respect, according to F.P.R.L. figures) and tend to dent rather than split when struck. In other categories willow is not particularly strong, properties corresponding to its light weight.

WORKABILITY. When seasoned, willow of all types can be worked very easily with most hand and machine tools, but sharp edges are necessary to obtain a good finish as the timber is somewhat woolly. Crack willow often tends to split during conversion from the log, and the timber is more woolly than that of cricket-bat willow.

SIZE and AVAILABILITY. Practically all supplies of willow in this country are home-grown. In addition to the timber grown specially for cricket bats there is a fair quantity available, especially of white willow. Logs are generally rather small, being up to 15 ft. long (average 7 ft.), and up to 15 ins. wide (average 6 ins.).

USES. First-class cricket bats are made only from the cricket-bat willow, but inferior bats are frequently of white and crack willows. The combined lightness and toughness of willow makes it ideal for artificial limbs, for which purpose it is widely used; the Bedford willow

is largely employed for this purpose. Owing to its property of denting rather than splitting, willow is valuable for the bottoms of carts and barrows, and for brake blocks; as it does not easily catch fire by friction it is particularly good for the latter purpose. Other uses include toys, flooring, clogs, crates, rims of sieves, charcoal (high class for medicinal purposes), chip baskets, hurdles, etc.

Where a permanent hedge and fence is required, unsplit and freshly cut ('live') stakes may be driven into the ground. If not driven too roughly the stakes will root and make a living fence.

CHAPTER VI

HARDWOODS OF MINOR IMPORTANCE

APPLE

BOTANICAL NAME: *Malus pumila* Mill. and spp.

Until comparatively recently the botanical name generally used was *Pyrus Malus* L.

Apple wood is obtained partly from wild apple (*Malus pumila* Mill.), occasionally from the common crab apple (*M. sylvestris* Mill.) and also from cultivated apple trees—when, for instance, an old orchard is felled.

FAMILY: *Rosaceae*, like pear, cherry and plum.

DISTRIBUTION. Wild apple is found in many parts of Europe and as far as N.W. Asia and the Himalayas; in Britain it extends northwards to the Clyde.

THE TREE. Few apple trees attain any great size and the wild apple is usually 20–30 ft. high and seldom more than 2 ft. in diameter (the majority being considerably smaller). The trunk is generally more or less crooked and the large rather tangled crown begins so low down that clean trunks of more than 10–12 ft. are rare.

It is a slow-growing tree and never cultivated in this country for its timber. The wild apple is not a tree which can be used in a forest, as it is too small, and, being a light demander, cannot be grown under another crop.

The fruit of wild apple, although not edible when raw, can be made into a conserve (although *M. sylvestris* Mill. is better for this purpose) and may be used for cider.

THE TIMBER. The sapwood is narrow and whitish to pale brown in colour, the heartwood is a deeper brown, often with a tinge of red (though not so red as the very similar wood of pear). Old trees sometimes show dark streaks in the wood.

It is hard, being comparable with oak and beech in this respect; heavy—weighing between 41 and 50 lbs. a cu. ft. when seasoned (average about 45 lbs.)—with a close, fine, and even texture.

DURABILITY. Not resistant to decay; tends to be damaged by Furniture beetles.

SEASONING. Somewhat difficult to season, and tends to warp badly and split. Once seasoned it stands well. (Kiln Schedule I probably suitable.)

STRENGTH. Hard and strong in most categories; U.S. tests on the same species show it to be about as tough as ash; difficult to split.

WORKABILITY. Works very well when seasoned if sharp tools are used; it turns excellently and takes a good polish.

SIZE and AVAILABILITY. Logs are very variable in size but are seldom more than 12 ft., or 1 ft. 6 ins. in diameter. There is not a large quantity available, but sufficient to meet the very limited demand.

USES. Apple is not very widely used, as it is generally regarded as an inferior substitute for pear. It is, however, an attractive timber and makes handsome stairs, banisters and such turned articles as door knobs; it is also a good carving wood.

Other uses include gunstocks, mallets, planes, tool handles (especially of hand-saws), inferior grades of mathematical instruments (rulers, set-squares, T-squares, etc.), turnery and hulls for small boats (the crooks of apple are said to be the ideal timber for this purpose). It has also been used for golf-club heads, and formerly straight coppice shoots were valued for the stocks of carriage whips.

BLACKTHORN (SLOE)

BOTANICAL NAME: *Prunus spinosa* L.

FAMILY: *Rosaceae*.

THE TREE. Usually a shrub but occasionally a small tree, mainly known for its fruit—the sloe, from which is made sloe gin.

TIMBER. Sapwood is reddish, heartwood greyish-brown often with pith-flecks. Very hard and tough.

Sometimes used for hay-rake teeth.

Straight coppice shoots are valued as walking sticks, and the chief source of the Irish shillelaghs.

BOX

BOTANICAL NAME : *Buxus sempervirens* L.

FAMILY : *Buxaceae*. In the genus *Buxus* there are about twenty species.

COMMON NAMES : Common Box, Boxwood, Turkish boxwood (this name is often given to the wood of box whether it comes from Turkey or not).

DISTRIBUTION. Box is native of Europe, parts of North Africa and Asia Minor, the Caucasus and Central Russia. It has been stated to extend as far as Japan. It is probably native to England, but this is disputed by some botanists, who claim that it was introduced by the Romans. It is particularly abundant on Box Hill, Surrey, and may be only indigenous to this area and possibly also to parts of Bucks, Kent and Gloucestershire. It has been recorded that £10,000 worth of box was sold from Box Hill in 1815.

THE TREE. Box is usually a bush, but under suitable conditions (especially on Box Hill) it grows up to 15 or 20 ft. in height with a diameter of 4–8 ins., although diameters of over 6 ins. are rare.

The small, dark green and polished evergreen leaves are well known, as box is often used as a formal hedge and is popular for topiary work since it may be constantly clipped without damage.

The tree is very accommodating as to soil, but thrives best on well-drained chalk or limestone formations. It is frost-hardy and will withstand a fair amount of shade and is useful as a shelter or hedge where other species will not grow. (Yew will tolerate very much heavier shade, but the fact that its foliage, and especially clippings, are poisonous to cattle sometimes renders it unsuitable for a hedge.)

Box is very slow growing, attains a great age, and is particularly free from insect and fungus pests. It may be raised from seed or, rather more easily, from cuttings and layers, as the seed often fails to ripen even under favourable conditions.

There are a large number of varieties, most of which differ very little. That most commonly found is the dwarf var. *suffruticosa*, which is used as an edging to flower beds. Left unclipped it will grow to 4 or 5 ft. An even smaller dwarf form is var. *prostrata*, horizontally branched and seldom exceeding 2–3 ft. in height.

THE TIMBER. Boxwood is light yellow in colour with no obvious distinction between the heartwood and sapwood, and very seldom any figure at all. The home-grown wood tends to be paler in colour than imported boxwoods.

It is very hard with an extremely fine and uniform texture with a lustrous surface. The grain is variable and is often somewhat curly, more so than Turkish boxwood. A very heavy wood; its weight varies between 53 and 72 lbs. per cu. ft. when seasoned, but is generally about 60 lb.

It is generally free from heart shakes, but spiral grain occurs fairly commonly, and also small knots.

DURABILITY. The wood is moderately resistant to decay, but as it is not used in the open or for constructional work, this property is not very important.

SEASONING. Boxwood is difficult to season, being very apt to split or develop surface checks. The trees should always be winter felled and immediately converted. Various methods are advocated to avoid splitting, the most successful of which is that worked out by the Forest Products Research Laboratory, in which a longitudinal saw cut is made down to the heart; this cut widens as the timber dries, but the rest of the wood remains free from splits. Chemical seasoning may also be used, but there is a tendency for the timber to become hygroscopic and corrosive to metals. Older and more primitive methods were used; for instance, French turners kept the wood in a cellar for 3–5 years, and when ready for using soaked it for 24 hours, then boiled for a time. They then wiped the wood dry and kept it in sand or bran until the moment it was to be put on the lathe. Another method is to place the timber in a dry shallow pit in the ground and cover it with straw and leave it for two years; when required for use it is removed, roughly shaped and thoroughly steamed. (Kiln Schedule III suggested.)

STRENGTH. The timber is extremely hard (about twice as hard as oak) but somewhat brittle; it is highly resistant to crushing along the grain. Occasionally specimens will have prominent areas of reddish-coloured wood, this is compression wood and is extremely brittle and difficult to work; it is sometimes called 'red boxwood.'

WORKABILITY. Although so hard, box works very well with sharp tools and is a first-class wood for carving, turnery and engraving. Rather more difficult to work than imported box; a small cutting angle (of 20 degrees) is desirable to avoid 'picking up' in planing. The timber

should also be firmly held against cutting edges or it will tend to ride over them without effect. Even in Roman times the working properties of the wood were recognised and Virgil describes it as

' Smooth-grained and proper for the turner's trade,
which curious hands may carve, and steel with ease invade.'

SIZE and AVAILABILITY. Home-grown box is usually obtainable in diameters of 1–4 ins., occasionally up to 6 or 7 ins.; there is only a small quantity available. Imported box is generally in fillets of 3–4 ft. long and 4–8 ins. in diameter.

Like *Lignum vitae*, box is sold by weight and not by volume.

USES. Boxwood has been prized for hundreds of years, particularly for carving and turnery, musical instruments, etc. It was popular for inlaying in cabinet making, for which purpose it was used freely in all the famous furniture styles : Sheraton, Jacobean, Queen Anne, etc. One of its most important uses was for blocks for wood engraving; it is still the best wood for this purpose, but there is only a small amount of printing done by this method at the present time.

Important modern uses are : Turnery bosses ; mathematical instruments (rulers, set-squares, etc.); shuttles ; small pulley-blocks and dead-eyes ; spindles ; combs ; inlay ; punners ; small boxes ; tool handles ; mallet heads ; chessmen and draughts ; jewellers' burnishing wheels ; sawdust is used for cleaning jewellery.

During the 1914–18 war, home-grown box was used in the manufacture of shells, and supplies were heavily depleted for the purpose.

IMPORTED BOX

Most of the time boxwood used in Britain is imported, various names are given descriptive of the country of origin; thus are recognised : Abasian box, Anatolian box (from Asia Minor) ; Circassian, Corsican, French, Parthenian and Persian box.

OTHER COMMERCIAL BOXWOODS

CAPE BOXWOOD (*Buxus macowani* Oliv.) from S. Africa is very similar to the European species but grows to a much larger size, up to 40 ft. high and 4 ft. in diameter. It is not so valuable for engraving, but is used for turnery.

BALEARIC or MINORCA BOX (*Buxus balearica* Lamarck) is believed to be confined to the Balearic Islands, Spain and Sardinia, although some authorities credit it with supplying a proportion of the Turkish boxwood. It has been introduced into England but is very rare.

There are several species of box in India, China and Japan, but these are only used locally and not exported.

A number of woods resembling the true box (*Buxus*) have been given the same name, and are used for similar purposes : the most important of these are as follows :

WEST INDIAN or MARACAIBO BOXWOOD (*Gossypiospermum praecox* (Griseb.) P. Wilson) is found in Venezuela and is the most important of commercial boxwoods, having largely replaced Turkish boxwood for almost all purposes except blocks for fine-quality engravings.

KAMASSI BOXWOOD or KNYSNA (*Gonioma Kamassi* E. May) from S. Africa is used particularly for shuttles in silk mills, it is not satisfactory for engraving blocks.

INDIAN BOXWOOD (*Gardenia latifolia* Ait.) is a whitish wood, sometimes with a grey or brown tinge, of poorer quality than true box, but useful for tool handles and turnery.

SIAMESE BOXWOOD (*Gardenia* spp.) is similar to the Indian but lighter in colour. It is cheaper than true box.

AMERICAN DOGWOOD (*Cornus florida* L.) is used as a substitute for boxwood, especially for weavers' shuttles in America. The wood is pinkish to red-brown, sometimes with a greenish tinge and is hard and tough, but straight grained and easy to work.

There are a number of other timbers given the name ' box,' *e.g.*, a group of Australian timbers (including brush box, etc.) which have only a superficial resemblance to true box and cannot be used for the same fine work.

ELDER

BOTANICAL NAME : *Sambucus nigra* L.

FAMILY : *Caprifoliaceae*, which includes honeysuckle and the wayfaring tree (*Viburnum Lantana* L.) and the guelder rose (*V. Opulus* L.).

OTHER NAMES : It is also known as elderberry, and should not be confused with box-elder (*Acer Negundo* L.) which belongs to the maple group.

DISTRIBUTION. Elder is native of Europe (including Britain), where it is widely distributed ; it extends to North Africa and West Asia.

THE TREE. It is usually found growing in the hedgerow or amongst scrub, and is often of a low, bushy form, but on a good loamy soil where there is plenty of moisture it becomes a small tree 20–30 ft. high. The trunk is generally rough and crooked.

Elder will grow under very adverse conditions,

in dark and damp situations, under heavy shade, etc., but always assumes a bush-like form. It grows very rapidly when young and can be cultivated as easily as willow by cuttings. In fact, is useful for producing quickly a hedge or live screen in this way.

The well-known elderberries, which are produced in large numbers, are used by country people for wine and also for various medicinal purposes—for which the flowers and even the bark are sometimes used.

The young twigs have a very large pith, which is easily extracted (see also under ' uses ').

THE TIMBER. The sapwood is white and the heartwood straw-coloured to pale brown, on quarter-sawn surfaces there is a faint but pleasing figure due to the large rays, and a slight lustre.

The texture is close and fine but the grain usually rather twisted. When green the wood is soft, but it becomes very hard with age. It is heavy, weighing about 49 lbs. per cu. ft. when seasoned.

DURABILITY. Not very durable.

SEASONING. Difficult to season, tending to warp and split in the process.

STRENGTH. A tough and strong wood.

WORKABILITY. It works fairly well when seasoned and is a good turning wood.

SIZE and AVAILABILITY. Elder is usually very small and crooked, but stems up to 7 or 8 ins. in diameter are not uncommon ; on the other hand, the demand is at present very small. There are ample supplies of elder growing in copses, hedges, etc.

USES. *Wood.* Used to a small extent for turnery and has been used as a substitute for box for rulers, etc. In America the elder is also used for combs. Evelyn, in his ' Silva,' described it as valuable for 'cogs of mills, butchers' skewers and such tough employments.'

It is a wood that could well be used for small turned articles to a larger extent than is the case at present, as it is both tough and fine-grained.

Pith. The pith from young shoots is used in optical work and for cutting microscopic specimens in laboratories and also for medicinal work. The young shoots from which the pith has been removed is sometimes used for crude musical pipes.

HAWTHORN

BOTANICAL NAME : *Crataegus Oxyacantha* L. and *C. monogyna* Jacq.

FAMILY : Belongs to the family *Rosaceae* (which includes apple, pear, plum and cherry). The two species of hawthorn are distinguished by the following botanical characteristics : (*a*) *C. Oxyacantha* L., the flowers have two styles, and (*b*) *C. monogyna* Jacq., the flowers have one style and the twigs are more spiky ; this is much more common a tree. The timber of the two is, as may be expected, identical, and the trees themselves are so similar that they may be described as one.

OTHER NAMES : May, Whitethorn and Quick.

DISTRIBUTION. Hawthorn is distributed over most parts of Britain, but is more frequent in the northern regions ; it extends, however, to Central Asia, Syria and North Africa. It is native to Britain.

THE TREE. Well-grown trees reach 25 ft. in height, but specimens up to 40 ft. are found with a diameter of 1-3 ft. The trunk is usually twisted and often fluted and the large crown begins low down, so that there is comparatively little timber even in a fair-sized trunk.

It is very common both as a tree and even more as a hedge, for which purpose it is ideally suited (being regarded as the best of all hedging plants) as it not only stands any amount of lopping and trimming, but forms a dense, interlacing network of twigs, and so makes a hedge that is almost impenetrable.

It will thrive best on a limy, fairly dry loam, but will grow on most soils. It is wind-firm, frost-hardy, and will tolerate a considerable degree of shade. It grows slowly and is very long lived.

The fruit consists of the well-known haws.

THE TIMBER. The wood is yellowish-white to pinkish in colour with no obvious distinction between heartwood and sapwood. It is often marked with a number of dark streaks (pith flecks) and is hard and heavy.

It is similar in appearance and properties to apple and pear, though generally rather pinker in colour and more streaky.

DURABILITY. The wood is fairly durable in the open.

SEASONING. Inclined to shake during drying.

STRENGTH. A tough, strong wood.

WORKABILITY. Needs sharp tools and is somewhat difficult to saw.

SIZE and AVAILABILITY. Although a common tree the trunks are usually too deeply furrowed to be of great timber value. Logs may be 5-10 ft. long (average about 6 ft.) and 12-24 ins. in diameter.

USES. The wood is useful for turnery (tool handles, etc.) and is one of the best substitutes for box for engravers' blocks. Straight young

shoots are sometimes used for walking sticks. It is also a valuable timber for destructive distillation.

HAZEL

BOTANICAL NAME : *Corylus Avellana* L.

FAMILY : *Betulaceae;* the same family as birch, hornbeam and alder.

OTHER NAMES : Filbert, Cobnut and Nut-wood.

DISTRIBUTION. Hazel is found in most countries of Europe except the extreme north, and also West Asia and North Africa ; it is native to Britain.

THE TREE. Normally hazel is a shrub but sometimes develops into a small tree about 20 ft. high with an irregular, often furrowed trunk that is seldom more than 9–12 ins. in diameter.

As coppice hazel is one of the most frequent types of underwood found in our woodlands ; it is a moderate shade-bearer. It is of particular value as coppice since the shoots are straight and flexible. Unfortunately it is often badly damaged by rabbits.

It will grow on most soils that are not marshy, and is very suitable to chalky districts ; hazel is frost-hardy and will succeed with any aspect.

Cultivation. It may best be propagated either by planting suckers or by layering. Coppice is usually grown on a 14–17 years' rotation according to the soil.

In some parts of the country (*e.g.*, Kent) hazel is cultivated for its nuts, although the bulk were imported from Spain.

TIMBER. Whitish to pale red-brown with no distinct heartwood ; the grain is usually straight and the texture very fine and uniform, the surface is slightly lustrous.

It is fairly soft and moderately heavy, about 35–46 lbs. per cu. ft. when seasoned.

The best quality wood is said to be produced on a chalky soil.

DURABILITY. Not durable in the ground.

SEASONING. Natural air seasoning is sufficient for most purposes, larger sizes of converted timber is inclined to shake if rapidly dried.

STRENGTH. Very elastic ; easy to split.

WORKABILITY. Works well and finishes with a smooth, bright surface.

SIZE and AVAILABILITY. Large sizes are rare, generally less than 1 ft. in diameter, larger stems are often furrowed. Most of the supplies of hazel are in the form of coppice shoots.

USES. The larger sizes may be used for a variety of small turned goods and small cabinet work. The coppice shoots are widely used for wattle hurdles (for which purpose it is the principal wood), hoops for barrels and crates, hop sticks, pea and bean sticks, hedge stakes and walking sticks. At one time it was used for ceiling laths and for ' wattle and daub ' houses. Twigs are traditionally used by water diviners, and a popular wood with gipsies for clothes-pegs.

HOLLY

BOTANICAL NAME : *Ilex Aquifolium* L.

FAMILY : Holly belongs to the most important genus in the family *Aquifoliaceae.* The famous Yerba Maté tea of South America is a species of *Ilex* (*I. paraguariensis* St. Hil.).

DISTRIBUTION. Holly is widely distributed in Central and Southern Europe and West Asia. It is native to Britain.

THE TREE. When growing wild holly is a small tree seldom more than 20–25 ft. with a diameter of 9–12 ins. Many specimens, especially when grown under cultivation, reach 50 ft. and even up to 80 ft. in height with a diameter up to 3 ft.

It is one of the commonest hedgerow and garden trees and makes probably the best of evergreen hedges, as it is wind-firm and retains its leaves almost to the ground. It forms an excellent shelter either as a tree or a hedge. It is extremely hardy, although attains its best size when sheltered. It prefers light, dry soils containing lime and some humus, it will tolerate any aspect and is a great shade bearer (although usually assumes a bush-like form when grown under dense shade).

Cultivation. Holly is best grown from seed, the berries should be mixed with earth or sand and kept in the open for a year turning occasionally before sowing.

Varieties. There are numerous varieties of holly having different types of variegated leaves, coloured berries, etc.

THE TIMBER. Holly is more dead white than any other timber, although occasionally there is a faint greenish tinge ; no distinction is visible between sapwood and heartwood. Its very fine and uniform texture in conjunction with its colour gives it a strong resemblance to ivory. The grain tends to be irregular. It is hard and heavy, weighing from 45–55 lbs. per cu. ft. when seasoned.

DURABILITY. Not resistant to decay.

SEASONING. Difficult to season and apt to warp badly. Logs should be converted immediately after felling and stacked in a fairly dry and sheltered place in order to retain the whiteness of the wood.

STRENGTH. A strong and tough timber.

WORKABILITY. Needs sharp tools, but is capable of an excellent finish and takes a high polish. It turns well. In planing a small cutting angle is desirable, the F.P.R.L. recommend 15 or 20 degrees for material with irregular grain. It glues satisfactorily and stains and polishes well.

SIZE and AVAILABILITY. Logs vary considerably in size, but average about 6–10 ft. long and 10–12 ins. in diameter. Supplies are limited, for, although the tree is common, it is seldom felled for timber.

USES. Holly is mainly used for inlay work and, when stained black, as a substitute for ebony in handles of tea pots, brush backs, etc.; it is valued for the linings of cigarette and similar boxes.

It is also useful for engraving, especially for calico printing, turnery (tool handles, etc.), clogs and in veneer for marquetry, and in Tunbridge ware.

Straight coppice shoots are valued for walking sticks and whip handles.

IMPORTED HOLLY

AMERICAN HOLLY (*Ilex opaca* Ait.). Very small quantities have been imported; it is almost identical to the British species.

LABURNUM

BOTANICAL NAME: *Laburnum anagyroides* Med.

Formerly known as *Laburnum vulgare* J. S. Presl.

FAMILY: *Leguminosae* (see note under False Acacia).

OTHER NAMES: It is sometimes known as Golden Rain, Bean-trefoil and Pea-tree. The wood has been called False Ebony.

DISTRIBUTION. Native of Central and Southern Europe, where it is found wild in the mountain forests. It was introduced into Britain about the end of the sixteenth century.

THE TREE. It is a small tree, 20–30 ft. in height and seldom more than 1 ft. in diameter. The crown is spreading, branching often begins close to the ground, so that good clean boles are rare. The yellow, pendulous racemes of flowers are well known.

As an ornamental tree in gardens and parks the laburnum has been widely planted, but it has not been grown in woodland.

It will grow on most soils, but needs a deep, fairly light, dry loam to attain its best development. It prefers a sheltered situation although it is hardy.

Care must be taken as to where the tree is planted, as both the bark, seed and leaves are poisonous to cattle (but not to rabbits, which damage young plants).

Cultivation. Fertile seed is produced abundantly and should be sown in March and the seedlings transplanted at the end of a year.

TIMBER. The sapwood is narrow and yellowish white and sharply defined from the heartwood, which is a beautiful rich yellowish or greenish-brown, darkening with age to a deep brown and sometimes almost black. It has a lustrous surface and plain-sawn boards show an attractive figure owing to the difference in colour between the masses of fibres and the lighter parenchyma.

The grain is generally straight and the texture fairly fine. The wood is hard and heavy, weighing from 45–55 lbs. per cu. ft. when seasoned (average about 47 lbs.).

It is very similar both in appearance and properties to false acacia and is difficult to distinguish.

DURABILITY. A very durable wood, which may be used in the ground without treatment, but the centre of the tree is inclined to become attacked by heartrot early in its life.

SEASONING. Easy to season.

WORKABILITY. Works fairly well with sharp tools, veneers well and turns excellently, takes a very fine polish.

SIZE and AVAILABILITY. Only small logs are available, usually not more than 6–8 ft. long and up to 9–12 ins. in diameter.

USES. It is valuable wood for cabinet work, furniture, inlay, turnery, musical instruments, knife and other handles; veneers of the end-grain are sometimes used as inlay for furniture and are known as 'oyster shells.'

LABURNUM—SCOTS

(*Laburnum alpinum* J. S. Presl.)

This is very similar to the common laburnum but has a somewhat thicker trunk and is preferable for gardens as the racemes of flowers are longer.

MAPLE—FIELD

BOTANICAL NAME: *Acer campestre* L.

FAMILY: It belongs to the family *Aceraceae*, which includes sycamore and all the true maples.

It is the only species of *Acer* native to England.

OTHER NAMES: Common, English or Hedge Maple.

DISTRIBUTION. A common species in many parts of Europe; it is also indigenous to England, but probably not to Scotland although it has become naturalised there.

THE TREE. When well grown field maple is about 20–30 ft. high, very occasionally up to 70 ft., with a diameter of 9–12 ins. It is more commonly found as a bush and is very frequent in the hedgerows of Southern and Central England and also as undergrowth in woodlands. As a tree it has a rounded, rather neat crown and the foliage is attractive, especially in the autumn when it turns rich yellow, for this reason it has considerable ornamental value.

It is very hardy except at high altitudes and will grow on any except the poorest soils; it will stand dry conditions and is a shade bearer. It is used for covers and as a hedge, but is not worth planting for timber owing to its small size.

THE TIMBER. The wood is pale brown or whitish with no obvious distinction between sapwood and heartwood; the planed surface has a satiny lustre and occasionally dark streaks (pith flecks) are present. Mottle, curl and ripple figures are sometimes found, and these make the wood extremely handsome; bird's-eye figure is also found.

The texture is fine and compact; the wood is hard and heavy (about 50 lbs. a cu. ft. when seasoned).

Field maple resembles sycamore in appearance and properties although darker in colour and slightly harder.

DURABILITY. Not very durable in the open.

SEASONING. Somewhat difficult to season, especially if curly grain is present.

STRENGTH. A tough, strong wood.

WORKABILITY. Works fairly easily and is an excellent turnery wood; it takes a high polish.

SIZE and AVAILABILITY. Only small logs are available, seldom more than 6–10 ft. long or 9–12 ins. in diameter. Owing to the fact that it is often lopped and layered in hedges there is very little available of any useful size.

USES. The timber is used for small turnery, small tools, tool handles, etc., and also for small cabinet work, and such articles as fancy pipes, snuff boxes, etc. When in sufficient quantity and size it makes good flooring.

MAPLE—NORWAY

BOTANICAL NAME: *Acer platanoides* L.

FAMILY: *Aceraceae*.

OTHER NAMES: Sometimes simply called Maple or (rarely) Plane Maple.

DISTRIBUTION. The tree is native of Continental Europe and is widely distributed from Norway southwards and as far as European Russia. It is not indigenous to Britain, having been introduced in 1683.

THE TREE. It is a fairly large tree, commonly 60–70 ft. high and occasionally up to 90 ft. with a diameter of 2 ft. or even up to 3 ft.

It has been widely planted as an ornamental tree but hardly at all in forest for the production of timber. Bean describes it as 'one of the handsomest, hardiest and most vigorous of introduced trees.'

Most soils are suitable, even dry, sandy ones, and it is very suitable for planting near the sea. It is frost-hardy, grows rapidly when young and is easily raised from seed. It will stand a fair degree of shade although it can hardly be described as a shade-bearer.

Maple has most of the sylvicultural characteristics of sycamore but is more frost-hardy and less exacting as to soil.

There are a number of varieties, many of which are highly ornamental.

THE TIMBER. The wood is white or inclining to become grey with age. It is fine textured, hard and fairly heavy (weighing about 43 lbs. a cu. ft. seasoned), works easily and takes a good polish but is apt to warp and split in drying.

It is very similar, both in appearance and properties, to the field maple and sycamore, though rather inferior to the latter and slightly milder.

It may be used for cabinet work turnery, flooring, tool handles, gun-stocks, musical instruments, etc., in fact for the same purposes as sycamore (q.v.).

There are very limited supplies of maple as it is almost entirely an ornamental tree.

IMPORTED MAPLE

A large quantity of maple has been imported from Canada, this is the product of the hard or sugar maple (*Acer saccharum* Marsh). It is highly esteemed as flooring, especially for ballrooms and squash courts; and also used for furniture and interior decoration. The bird's-eye maple is mainly furnished by this species.

MULBERRY—COMMON

BOTANICAL NAME: *Morus nigra* L.

FAMILY: *Moraceae*, which comprises a group of trees and shrubs distributed in many parts of the world and includes the figs, one of the so-called rubber trees (*Ficus elastica* Roxb.) and the West African timber Iroko.

DISTRIBUTION. It is native of the Orient and has been cultivated in China and Japan for thousands of years. It has been grown in

Britain at least since the early part of the sixteenth century.

THE TREE. A small tree, 20–30 ft. high with a short rough bole, which may be 1–2 ft. in diameter, and a heavy spreading crown often wider than the height of the tree.

It is not frequent in this country and grows only in gardens and parks, usually for the fruit, which is made into conserves and drinks, or purely for ornamental purposes.

THE TIMBER. The sapwood is white or yellowish and narrow and the heartwood is pale yellow-brown when fresh becoming reddish-brown like old Spanish mahogany and sometimes almost black, with exposure. It is very similar to false acacia in general appearance.

The grain is often interlocked and variable and the texture is somewhat coarse. It is hard and fairly heavy, weighing 37–45 lbs. per cu. ft. when seasoned.

DURABILITY. Very durable as timber, being similar in this respect to false acacia, but old trees are usually hollow owing to attacks by heart-rotting fungi.

SEASONING. Not difficult but inclined to twist.

STRENGTH. A tough wood, very difficult to split.

WORKABILITY. Works fairly well with sharp tools, veneers easily and turns well; it takes an excellent polish.

SIZE and AVAILABILITY. Only very rarely are logs obtainable, and these are seldom more than 4–6 ft. long or 12–18 ins. in diameter.

USES. Mulberry was at one time highly valued for furniture, for which it was often veneered; also for inlaying, turnery and snuff boxes. Owing to the scarcity of the wood it is now little used, but is extremely attractive and could well be used for small, ornamental work, furniture and turnery.

WHITE MULBERRY

(*Morus alba* L.)

A larger tree than the common mulberry (30–45 ft. high and 2 ft. or more in diameter), it is not so common in England but very widely cultivated in Southern Europe for the feeding of silkworms. It is hardy in England and could, with advantage, be more widely cultivated.

PEAR

BOTANICAL NAME: *Pyrus communis* L. and spp.

FAMILY: *Rosaceae* (see also under 'Cherry').

COMMON NAMES: Most of the pear wood used in commerce is derived from the wild pear, sometimes called Choke-pear (*Pyrus communis* L.): a very small proportion comes from cultivated pears.

DISTRIBUTION. Native of Europe and N. Asia, it is found scattered in the forests of Central and Eastern Europe, and wild in the southern half of Britain (although it is probably not indigenous). It is seldom found north of Yorkshire.

THE TREE. Generally a small tree, 20–40 ft. high (occasionally up to 60 ft.) with a stout trunk that may be up to 3 ft. in diameter, but is usually not more than 1–2 ft.

Pear is not very frequent in Britain, but grows singly or in small groups in woodlands, commons, etc. It prefers a rather dry soil and a sheltered situation. Although a long-lived tree, it is a fairly rapid grower, under good conditions often reaching 40–50 ft. in thirty years with a diameter of 12–18 inches.

The fruit is not edible, but the tree is the original parent of most of the cultivated pears.

Varieties: P. communis var. *cordata* is found locally in the western counties of England; it is very similar to the wild pear, but the leaves and fruit are smaller.

THE TIMBER. A beautiful wood of excellent quality. Yellowish-red to pale pinkish-brown in colour, there is no distinct demarkation between heartwood and sapwood, but the centre of old trees is sometimes a darker chocolate-brown.

The grain tends to be irregular, and the texture is exceedingly fine and uniform, the planed surface is extremely smooth, although dull. It is hard and moderately heavy, weighing 40–50 lbs. per cu. ft. when seasoned.

The home-grown timber is rather harsher in quality than that grown in Central Europe. Occasionally figured timber is found which is valuable for veneers. The wood is similar to that of apple.

Logs from cultivated pear trees are less valuable than wild pear, as they have mostly been grafted and there is a difference between the timber of the two stocks, with resultant unequal shrinkages, splitting, etc.

DURABILITY. Not particularly durable in the open, but lasts well if kept reasonably dry; subject to attack by Furniture beetle.

SEASONING. There is a tendency to twist in drying. A steaming treatment prior to final seasoning is advantageous, and timber imported from Central Europe is generally treated in this manner in the country of origin. (Kiln Schedule I probably suitable.)

STRENGTH. Tough and strong, difficult to split.

WORKABILITY. Works excellently in all directions of the grain ; it turns well and is one of the best carving woods : takes a high polish and veneers well. In planing a cutting angle of about 20 degrees is desirable.

SIZE and AVAILABILITY. Logs are variable in size, clean boles of more than 6–10 ft. are rare ; diameters range from 8 ins. to 2 ft. There is very little timber available, but the tree could well be planted more extensively as the wood is so valuable. Most of the pear-wood of commerce is imported from Central Europe.

USES. The most important modern use of pear-wood is for drawing instruments : T-squares, set-squares, curves, etc. ; it is also used for turnery, handles for such tools as hand-saws, etc., carving, calico-printing blocks, inlay, cabinet-work and furniture. It is often stained black and used as a substitute for ebony, especially for piano keys and picture frames.

Figured logs yield very attractive veneer, which may be used for cabinet work, furniture, etc.

ROBINIA

BOTANICAL NAME : *Robinia pseudoacacia* L.

OTHER NAMES : Also known as False Acacia, or Locust Tree, and the timber is called in some districts Golden Oak.

FAMILY : *Leguminosae*, which is one of the largest plant families, having over 1,200 species in all parts of the world ; although herbaceous species such as clover, are common and indigenous there are no native trees of this family in Britain. The laburnum is the best known tree of this family in this country.

DISTRIBUTION. Native of the Eastern United States, it is now found in many of the warmer parts of Europe, being popular in France, where it is grown quite extensively for timber. It was introduced into Britain about the beginning of the seventeenth century.

THE TREE. In Britain the tree is usually grown in the open and so does not attain its maximum height ; usually trees are 50–60 ft. high with a rather twisted trunk. When grown under forest conditions the trunk is straight and readily cleans itself of branches. Diameters are usually not more than 2 ft., occasionally up to 4 ft.

The tree is not common in England, being mainly grown in gardens for ornament (the showy white flowers and feathery foliage are attractive).

It will thrive on poor, sandy soils, but not on heavy or wet soils. It has been used to fix drifting sands and also planted on railway embankments in order to protect other trees from sparks. A very hardy tree, but needs plenty of light. It coppices easily and the tough, durable stool shoots make good fencing. It may be cultivated either from seed (which are best obtained from America), cuttings or layering. For planting out 1 yr. 1 yr. transplants are best.

Old trees resemble elm in their tendency to drop large branches without warning : old trunks also tend to become hollow, therefore a long rotation should not be used—40–60 years is generally most suitable.

It is a very useful tree for street planting as it endures a smoky atmosphere and can be lopped and pollarded without harm or even undue malformation of the tree. It comes into leaf late and sheds its leaves early in autumn.

THE TIMBER. The sapwood is pale yellowish and very narrow—seldom more than five annual rings, it is sharply distinct from the heartwood, which is greenish-yellow when freshly cut but darkens with age to a greenish golden-brown. Sometimes it becomes a beautiful yellowish-brown and has been mistaken for satinwood. Alternating bands of light and dark spring and summer wood give an attractive appearance to the wood, especially in turned articles.

The grain is generally straight and the texture somewhat coarse and open, but the surface is satiny. It is hard and heavy (usually 40–50 lbs. a cu. ft. when seasoned).

DURABILITY. An exceptionally durable wood that can be used in the ground without treatment ; posts have been known to stand for 30 years without decaying. Liable to attack by Lyctus beetles ; high fire-resistant properties.

SEASONING. Stated to shrink considerably in seasoning, and with a tendency to warp. (Kiln Schedule I recommended.)

STRENGTH. A very strong timber, shock resistant (almost as tough as ash), and with excellent bending properties.

WORKABILITY. Works easily with most tools and turns excellently : it splits easily and usually straight. Somewhat difficult to nail, but glues and polishes well. Care should be taken when working to remove any splinters from the skin quickly or sores may result, due to a mild poison secreted by the wood.

SIZE and AVAILABILITY. Little false acacia is available as it is mainly grown for amenity purposes. It is, however, well worth far more extensive planting for its valuable timber. Logs usually range from 6 to 15 ft. long and 12–18 ins. in diameter.

USES. The wood is used quite extensively in France, often as a substitute for ash—in shafts

for carts, felloes and spokes of wheels, agricultural implements, etc., also for ribs of vessels, ladder rungs, piles and sleepers. It is an excellent furniture wood and often resembles satinwood when old and well polished.

Other uses include *tree-nails* (pegs or wooden nails used in shipbuilding, which have to be very elastic and tough), gate posts and fencing. Burrs produce very handsome figuring and are veneered for cabinet work, and coppice poles make excellent posts and stakes.

ROWAN (MOUNTAIN ASH)

BOTANICAL NAME: *Sorbus Aucuparia* L. Formerly known as *Pyrus Aucuparia* Gaertner.

FAMILY: *Rosaceae.*

OTHER NAMES: Quickbeam, Quicken tree, White Ash, Fowler's Service, Witch-wood, Witchen, Hen-drunks.

DISTRIBUTION. Very widely spread in Europe, from Iceland to the Mediterranean, and into Asia. Native to Britain and characteristic of the Scottish Highlands.

THE TREE. A fairly small tree, 30–50 ft. high and up to 2 ft. in diameter. The crown is small and open so that other plants can grow beneath it.

It is very frequent in most parts of Britain, but in the south is mainly used either as an ornamental tree or as underwood (to ' nurse ' young oak plantations, etc.).

Rowan is one of the hardiest of our trees and the most accommodating as to soil, growing in the poorest types.

An excellent tree for small gardens, making a fine show with its white flowers and masses of red berries.

Cultivation. From seed, which should be mixed with sand or soil and kept in the open for a year before sowing; the mass should be turned occasionally.

THE TIMBER. Whitish sapwood not clearly defined from the pale reddish-brown heartwood. Pith-flecks are common, and are often irregularly scattered at the edge of the sapwood.

The texture is very fine and uniform and the surface somewhat lustrous. Fairly hard and moderately heavy, 35–50 lbs. per cu. ft. when seasoned.

The wood is similar to other species of *Sorbus* and *Pyrus*, *i.e.*, pear, apple, service and whitebeam.

DURABILITY. Not particularly durable in the open.

STRENGTH. Very tough and elastic; difficult to split.

WORKABILITY. Works easily and planes with a smooth surface; capable of a high polish.

SIZE and AVAILABILITY. Logs are mostly small, seldom more than 6–10 ft. long and about 9–12 ins. diameter (sometimes up to 18 ins. or occasionally 2 ft.). Comparatively little is obtainable owing to the scarcity of economically large sizes.

USES. May be used for cabinet work, turnery, carving, tool handles. Coppice shoots are useful for hoops, crates, rough basket work, etc. Evelyn records that it was formerly used for bowls.

SERVICE TREE

BOTANICAL NAME: *Sorbus Torminalis* Crantz.

The Service or Wild Service was formerly called *Pyrus Torminalis* Ehrh.

FAMILY: *Rosaceae.*

DISTRIBUTION. Native of most parts of Europe, except the extreme north, including Central and Southern England. It is not found in the wild state further north than Lancashire and Yorkshire.

THE TREE. A small tree, 30–40 ft. high, occasionally up to 60 ft. with a trunk 1–2 ft. in diameter. It is a very handsome tree but comparatively rare either wild or cultivated. It grows best on a heavy clay and does not require much moisture.

The fruit is sometimes eaten but needs to be kept until decay begins, as with medlars; in Kent and Sussex the fruit is known as ' chequers.'

THE TIMBER. The heartwood is yellowish-red, often with lighter-coloured streaks, the sapwood is slightly paler. It is hard and with a close, smooth texture, moderately heavy and takes a good polish.

The wood is almost identical with that of Rowan (q.v.) and is used for the same purposes, *i.e.*, small cabinet work, turnery and carving. It is too scarce to have any real commercial value.

SPINDLE-TREE

BOTANICAL NAME: *Euonymus europaeus* L.

The spindle-tree will often form a small tree up to 25 ft. high with a diameter of little more than 6–9 ins., but the stem clear of branches for 6–10 ft. More usually it is in the form of a bush in hedgerows, where its red fruit and delicate foliage make it conspicuous and one of the most beautiful of our shrubs.

TIMBER. The wood is whitish, hard and very tough, with a fine texture, easily cut and turned. It was used for spindles at the time when

spinning was carried out in every home. It may also be used for small turnery, *e.g.*, skewers, etc., and is stated to make fine charcoal for crayons.

TREE OF HEAVEN

BOTANICAL NAME. *Ailanthus altissima* Swingle. (= *A. glandulosa* Desf.).

FAMILY : It belongs to the *Simarubaceae* or *Quassia* family, which comprise trees and shrubs mainly growing in the tropics.

OTHER NAMES : Known sometimes as Tree of the Gods and Ailanthus or Ailantus.

DISTRIBUTION. Native of Northern China and was introduced into Britain in 1751.

THE TREE. It grows to a large size, 50–70 ft. and occasionally 100 ft. in height and 2–4 ft. in diameter. It is grown only as an ornamental tree, frequently in large towns as it tolerates a smoky atmosphere and is one of the best town trees. The male and female flowers are produced on separate trees and only the female should be grown in towns as the male flowers have an unpleasant smell.

It grows best in the south of England, being apt to suffer from late frosts. It prefers a deep, dry and porous soil but is fairly accommodating. A very rapid grower, it often grows 3 ft. a year when young ; it is not long lived and matures at between 50 and 70 years.

Cultivation. It is necessary to take root cuttings from female trees for town planting because the sex of the tree cannot be determined until the tree is too old to transplant.

Sometimes young trees are cut back in coppice form and used for herbaceous borders, when leaves grow 2 or 3 ft. in length.

Var. *pendulifolia* Rehd. has drooping leaves, an attractive variety for town planting.

THE TIMBER. Ailanthus is very similar in appearance to ash, and has, in fact, often been mistaken for it.

The sapwood is broad and yellowish but not sharply distinct from the greyish-yellow heartwood.

The grain is coarse (coarser than ash—partly due to the faster growth of the tree) but the surface has a satiny lustre. The wood is moderately hard and heavy, weighing about 38–40 lbs. per cu. ft. when seasoned.

DURABILITY. Fairly durable.

SEASONS. Seasons fairly readily.

STRENGTH. No tests have been carried out, but the timber is not so elastic as ash, and cannot be used for the specialised purposes to which the latter is put.

WORKABILITY. Easy to work and capable of a good finish and polishes well. Rather difficult to split.

SIZE and AVAILABILITY. Very little timber is available, but when logs are obtainable they are often of good size.

The tree is inclined to fork early in its life and the average length of the bole is about 15 ft.

USES. It has been used for cabinets, cupboards, light furniture and fixtures, and would be an attractive wood for interior decoration, for which it could be used in veneer form.

TULIP TREE

BOTANICAL NAME : *Liriodendron Tulipifera* L.

FAMILY : *Magnoliaceae* or Magnolia family.

OTHER NAMES : Known as Yellow Poplar in America and the timber is called (in the U.K.) Canary Wood (or Whitewood) or American Whitewood.

DISTRIBUTION. Native to Eastern North America and introduced into England at the end of the seventeenth century.

THE TREE. A large tree, up to 100 ft. high and 3 ft. or more in diameter. It is one of the largest trees in Eastern N. America, growing to 200 ft. with diameters of 8–9 ft.

It is only grown in this country as an ornamental tree, but some excellent specimens exist, mainly in the South of England. It succeeds best on a deep well-drained loam and will grow well on chalky soils. As the tree suffers from early and late frosts it should be grown in a sheltered position.

A very handsome tree, it thrives fairly well in town parks.

Cultivation. The seed only ripens in very warm years so that it is best to obtain seed from America.

THE TIMBER. Varying in colour from whitish- to olive-green with occasional dark, purplish streaks, nearly always with a green tint. Soft, straight-grained, very fine and even texture, light in weight (about 28 lbs. per cu. ft. when seasoned).

DURABILITY. Not durable.

SEASONING. Rather slow and with a tendency to warp.

STRENGTH. Not very strong.

WORKABILITY. Very easy to work, takes a good smooth finish and polishes well.

SIZE and AVAILABILITY. Very little home-grown timber is available ; large quantities used to be imported from America. It could well be planted more extensively in South England as its timber is extremely useful.

USES. A general utility timber, useful for furniture, high-class joinery, interior decoration, engineers' patterns, dairy utensils, carving, sign-boards, etc.

WHITE BEAM

BOTANICAL NAME : *Sorbus Aria* Crantz.

FAMILY : *Rosaceae.*

OTHER NAMES : Common and local names include : Hen Apple, Whipcrop, Cumberland Hawthorn, Hoar Withy, Quick Beam and Sea Owler (in Lancashire and Westmorland).

The botanical name formerly used was *Pyrus Aria* Ehrh.

DISTRIBUTION. It is widely spread in Europe and is native to Britain ; it extends to Asia Minor and North Africa in some of its forms. It is characteristic of the chalk hills of Britain.

THE TREE. White beam varies in size from a shrub to a medium-sized tree—under favourable conditions—30–40 ft. or more high and 1–1½ ft. in diameter.

It is of local occurrence, being very frequent on chalky and limestone soils in South and South-East England, and rare in other districts. A hardy tree that does not require much moisture and thrives well on most well-drained soils although preferring those containing lime. The scarlet fruits, which are about ½ in. across are sometimes eaten in the fashion of medlars, *i.e.*, when partly decayed.

It is a handsome tree and produces valuable timber and could well be planted far more widely, *e.g.*, as a roadside tree, where it would best be grown in clumps.

Propagation is best by seeds, although the seedlings grow very slowly at first.

THE TIMBER. The wood is yellowish-white to light pinkish-brown, the annual rings show as darker lines and give a subdued but pleasing figure on plain-sawn surfaces.

The grain is fine and uniform and usually straight ; the wood is fairly hard and heavy, weighing about 45 lbs. per cu. ft. when seasoned.

It is very similar to the wood of rowan and service.

DURABILITY. Not particularly durable in the open.

SEASONING. Dries slowly and apt to warp if seasoning is at all hastened.

STRENGTH. A strong and tough wood, exceeding ash in the latter respect ; as hard as oak and with comparable compressive strength parallel to the grain.

WORKABILITY. When seasoned the wood is somewhat difficult to saw and plane, but with care an excellent smooth finish can be obtained ; it will take a high polish and is easy to turn, and carves well. Veneers easily.

SIZE and AVAILABILITY. Owing to the fact that whitebeam is often treated almost as a weed and cut back heavily, there are not many good-sized logs available, when obtainable they range from 6–10 ft. long and 9–18 ins. in diameter.

USES. The wood is excellent for such turned work as tool handles, bobbins, spools, reels, mallet heads, etc. It may also be used for small cabinet work, furniture and such purposes as handles of saws, etc. Recently it has been made into plywood and has proved very successful in this form.

CHAPTER VII

PRINCIPAL SOFTWOODS

CEDAR OF LEBANON

BOTANICAL NAME : *Cedrus libani* G. Don in Loud.

FAMILY : *Pinaceae.*

COMMON NAMES : The genus *Cedrus* (of which there are only three species) constitutes the true cedar ; this name has been applied to many other woods, both hardwoods and softwoods, which have a scent resembling that of true cedar, *e.g.*, Pencil cedar (*Juniperus virginiana*) ; Cigar-box cedar (*Cedrela* spp.) ; Red Cedar (*Thuja plicata*), etc.

DISTRIBUTION. Native to the mountains of Lebanon in Palestine, where the tree is now scarce, and to the Cilician Taurus in Asia Minor. It was introduced toward the end of the seventeenth century.

THE TREE. A very large tree, growing to 80–100 ft. in height and 5–8 ft. in diameter. When young it is pyramidal in shape, but with age usually becomes flat-crowned with enormous, almost horizontal branches. Owing to these branches, and the fact that the tree is usually grown in the open, there is seldom any length of clean bole.

It is very common in Britain as an ornamental tree, especially in churchyards, parks and, occasionally, in avenues.

Soil and Situation. Accommodating as to soil but grows best in moist, well-drained loam with a fairly deep subsoil; it will also succeed on drained peat soils. Very shallow, wet or heavy soils should be avoided.

Sylvicultural Characteristics. The tree is wind-firm, but older trees, with flat crowns are apt to suffer from snow-break.

It will not tolerate any degree of overhead shade, but is very hardy against frost and winter cold, although it attains its finest proportions in the warmer and drier parts of Britain.

It is slow growing and reaches a great age—in the mountains of Lebanon specimens up to 2,500 years old have been recorded.

The timber is not sufficiently valuable to warrant growing it as a forest crop in this country, but it is one of the most handsome and impressive trees for amenity purposes.

Cultivation. Seeds should be sown as soon after they are ripe as possible. Dallimore (*cf.* 'Handbook of Coniferæ') recommends that seeds be sown under glass (*e.g.*, in a cold frame) and states that if young plants are transplanted every two years they may safely be planted out up to a height of 10–12 ft.

THE TIMBER. The sapwood is yellowish-white and usually distinct from the heartwood, which is pale red-brown, becoming darker on exposure. The wood is characterised by its pleasant fragrance, which is due to the presence of an oil that is often distilled from cedar chips and used in insecticidal preparations and for other purposes.

It is usually straight grained, soft and light (weighing about 35 lbs. per cu. ft. when seasoned).

Large logs are inclined to have cup shakes and ring shakes.

DURABILITY. Home-grown cedar is very durable, and in its native habitat it bears a high reputation for durability. It is seldom attacked by insects, being protected by its scent, which also keeps away clothes moths, and so renders the wood valuable for clothes' chests, etc.

SEASONING. It is apt to develop heart shakes and to warp during seasoning.

STRENGTH. Not a very strong wood, tending to be brittle.

WORKABILITY. It works very easily with sharp tools and planes to a fine, smooth surface. It may be stained easily and takes a good polish. It takes nails well and glues without trouble.

SIZE and AVAILABILITY. Being almost entirely an ornamental tree, supplies are strictly limited and long, clean stems are exceedingly rare. However, logs of very large diameter are occasionally obtainable—up to 4 ft. (although the average is about 20 ins.); lengths are up to 30 ft., but usually not more than 12 ft.

USES. Cedar is an excellent wood for clothes' chests, wardrobes, etc. (as it protects clothes from moth) and makes attractive furniture and interior decoration, and may be used for good-class joinery.

It is a good carving wood and suitable for such outdoor purposes as fencing, gates, garden furniture, seed and plant boxes.

OTHER SPECIES OF CEDARS

ATLAS CEDAR

(*Cedrus atlantica* Manetti)

This species is very similar to the Cedar of Lebanon and can, in fact, only be identified with any degree of certainty by the stiffly erect leading shoot of young trees, compared with the drooping shoot of the Cedar of Lebanon.

The tree is native to Algeria and Morocco (on the Atlas Mountains), and was introduced about 1844. It is very hardy and withstands a smoky atmosphere better than other species of *Cedrus*.

THE TIMBER is identical to that of the Cedar of Lebanon.

DEODAR

(*Cedrus Deodara* (Royle *ex* Lamb.) Loud.)

In the Himalayas, where this species is indigenous, it forms immense forests and is one of the most important trees in India, certainly the most important conifer. It was introduced into Britain in 1831.

It differs from the other cedars in having more drooping branches and longer needles; it is one of our most graceful conifers, but is, unfortunately, not very hardy.

The timber is usually of slower growth than the other cedars, and the annual rings are more clearly defined.

CEDAR—WESTERN RED

BOTANICAL NAME: *Thuja plicata* D. Don (occasionally the now obsolete names *Thuja gigantea* or *Thuja Lobbii* are used by some nurserymen).

FAMILY: *Pinaceae.*

COMMON NAMES: Red Cedar, Thuja or Thuya, Western Arbor-Vitæ, Canoe Cedar. In Britain the tree is usually called Thuja. The name 'cedar' is not strictly accurate as the genus *Cedrus* comprises the only true cedars, although

the name has been applied to some hardwoods and softwoods from many parts of the world; any timber with a scent at all resembling that of *Cedrus* spp. is usually dubbed 'cedar', of one sort or another.

DISTRIBUTION. Native to West N. America from Alaska to Northern California. Its best development is in British Columbia, Washington and Oregon. It was introduced into Britain in 1853 by Lobb.

THE TREE. Thuja has not been grown long enough in Britain to determine with certainty its maximum dimensions, but there are examples 100 ft. in height and up to 3 ft. in diameter. In N. America the tree reaches 150–200 ft. with normal diameters of 3–8 ft., occasionally up to 15 ft.

It is a good ornamental tree, grown singly, with a handsome pyramidal form; the trunks tend to be very tapered. Frequently it is used as a hedge in gardens, etc., as it will endure clipping well. Of recent years it has been planted more widely by foresters, especially in mixtures.

Soil and Situation. It is accommodating as to soil and particularly useful for heavy clays, although it will even succeed on sandy loams if there is sufficient moisture in the soil. It does not demand a high rainfall and is successful in the Eastern Counties, although there is a tendency for it to be less frost-hardy under such conditions.

The best type of soil is a deep, fresh loam containing some lime. It will grow at high elevations and in exposed places and near the sea, but thrives best in sheltered situations. It prefers a northern aspect.

Sylvicultural Characteristics. Thuja is very wind-firm and is excellent for a shelter belt. It bears a considerable degree of shade (more than spruce) and can be used for under-planting. In the open it retains its branches almost to the ground, but cleans itself fairly well if planted closely.

It is very frost-hardy. When once established it grows fairly rapidly, and although slower than Douglas fir and larch it can be grown more densely and so produce a high yield per acre. An economic rotation is about 60–80 years, although a longer rotation might well result in better quality timber, more resembling that imported from Canada.

Cultivation. Normally raised from seed but cuttings will strike. For planting out 2 yr. 2 yr. or 2 yr. 1 yr. transplants are generally best, but two-year seedlings may be used if well grown.

Close planting is desirable in order to obtain clean timber, especially as the young trees have a somewhat columnar habit; 4 ft. by 4 ft. planting is generally used, and this is economic as thinnings are saleable.

Diseases. A fungus, *Keithia thujina*, sometimes attacks plants in the nursery and may be very destructive.

THE TIMBER. The sapwood is fairly narrow and yellowish in colour, merging into the heartwood which is normally brown or reddish-brown, but varies considerably. It has been found that timber from Canada is sometimes almost black in parts, and this colour has been associated with older or mature trees. When the timber is exposed to the weather it becomes a decided grey, often silver-grey. This change is utilised (in the Canadian timber) as weather-boards and shingles are allowed to weather naturally and impart an extremely attractive appearance to timber houses.

The timber is straight grained, slightly coarse in texture, and very soft; for the latter reason it should not be used where it will receive hard wear or the surface will quickly become scored. Red cedar tends to corrode unprotected iron, and itself becomes stained when in contact with metal. For this reason copper or galvanised iron nails should always be used.

It has a distinct fragrance and is very light, weighing about 24–26 lbs. per cu. ft. when seasoned.

As with most conifers introduced from N. America, the British timber is much faster grown, being obtained from younger trees and consequently coarser in texture and generally of inferior quality. There is considerable variation in the quality of the timber according to the part of the country in which it was grown, and the warmer parts tend to produce poorer qualities than the cooler.

DURABILITY. Cedar has very exceptional resistance to decay of all forms. Tests have been carried out on imported timber to ascertain its resistance to dry rot fungus, *Merulius lacrymans*, and it has been found to be immune to this fungus. It contains an essential oil which, whilst it does not 'bleed,' renders it immune to weather variations and decay. It is also highly resistant to insect attack.

It has been stated that red cedar grown in this country was less durable than that from Canada. This has been disproved by Cartwright (54) in a recent paper, in which he states that the resistance to decay of the home-grown timber is of the same order as that of the imported timber. He also shows that the outer layers of heartwood (the sapwood is not durable) are more resistant than the inner, this becomes more marked

towards the tip of the tree. The average resistance of the timber is highest in material from the base of the tree, and shows a progressive decrease up the tree.

SEASONING. The timber normally seasons fairly readily, though if grown under unsuitable conditions it shows excessive shrinkage. Once seasoned it is very stable and resistant to changes in moisture content. Some air-seasoning prior to kilning desirable. (Kiln Schedule I suggested.)

STRENGTH. Generally speaking Western red cedar does not possess high strength values. When used as a post or column it stands up well to compression, but as a beam under heavy loads it is not suitable. No figures are available as to the strength of the home-grown timber, but according to tests made by the Forest Products Research Laboratory on timber from British Columbia, it is about 15% less stiff than Baltic redwood, 20–30% inferior in bending strength, in resistance to suddenly applied loads and in crushing strength along the grain.

WORKABILITY. In general the working qualities of this wood are excellent, but it tends to pick up in some cases when pressure is applied in finishing, due to its softness. With care it can be finished to a smooth satiny surface. It stains well, but with the colour graduation tends to appear patchy; it paints well and holds glues satisfactorily.

SIZE and AVAILABILITY. The tree has not been planted long enough nor in sufficient quantities to provide more than very small quantities of timber of comparatively small sizes. It is, however, being planted in increasing quantities and should prove one of our most useful conifers. Before the war very large supples were imported from British Columbia.

USES. Owing to the small sizes available red cedar has been used largely for fences and other estate purposes, but whenever durability is required and the necessity for preservation eliminated, the wood is excellent, and for such purposes as weather boards, shingles, garden work, greenhouses, fencing, etc., Western red cedar is excellent. It can be used to every advantage in interior decoration, joinery, etc., and when polished (and in this respect due to its softness it would require a sealer) is extremely attractive. Other uses include telegraph and telephone poles, piling, cooperage, boxes, boats, etc.

The thinnings are especially valuable for posts, rails, stakes, etc., as they do not have the whorls of branches (forming awkward bulges and reducing the strength) as such trees as pine and spruce. Also the light weight is a valuable asset for gates.

CYPRESS—LAWSON'S

BOTANICAL NAME: *Chamaecyparis Lawsoniana* (A. Murr.) Parl. Also known as *Cupressus Lawsoniana* A. Murr.

FAMILY: *Cupressaceae* (some botanists include this family under the *Pinaceae*).

COMMON NAMES: When grown in America the tree is given a number of common names, the principal of which is Port Orford Cedar (q.v., p. 81).

DISTRIBUTION. It is native to S.W. Oregon and N.W. California, but has been planted extensively in most European countries; it was introduced into Britain in 1854, when it was received at Lawson's nursery, Edinburgh.

THE TREE. In N. America it grows up to 200 ft. with diameters of 6–8 ft., but such trees are of considerable age. In Britain it has not been grown long enough to determine its maximum growth, but specimens of 80–100 ft. in height are found.

It is a handsome ornamental tree, and mostly planted for amenity purposes and as a hedge in gardens, for which purpose it is admirably suited, as it may be clipped with impunity. It is the commonest cypress in Britain, and has recently become of interest to the forester and is being planted in close forest for the production of timber. The foliage is used by florists in making wreaths, and the lower branches may be cut and sold with advantage (and with no damage to the tree).

Soil and Situation. It will thrive on most types of soil that are not too wet or heavy and is one of the few conifers that will succeed on a chalky soil. The best growth is attained on good, fairly dry loam, and in a situation that is not too exposed.

Sylvicultural Characteristics. The tree will tolerate a considerable degree of shade, and is useful for underplanting such species as oak, and when used in this way produces straight, clean stems.

It is exceptionally frost-hardy, and is fast-growing, although less so than red cedar (which is usually preferred by foresters as it has a higher yield of timber).

It has been justly described as one of the most useful conifers we have, growing on almost any soil, hardy, fast-growing, and producing valuable timber. Its main disadvantages are a tendency to fork and to retain its lower branches.

Cultivation. Seeds ripen well and should be sown in April; the young plants need protection

against frost in the first year. For planting out 2 yr. 1 yr. or 2 yr. 2 yr. transplants are best.

Cuttings may also be used for propagation.

Diseases. The tree is very free from diseases.

Varieties. Lawson's cypress is extremely variable under cultivation, and a very large number of varieties are recognised. The most popular are those with different coloured foliage, *e.g.*, ' Golden King ', ' Silver Queen ', etc. There are also fastigiate types, spreading, pendulous and dwarf varieties.

THE TIMBER. The wood is whitish, with sometimes a yellowish tinge, little or no distinction being visible between heartwood and sapwood, although the former is sometimes pale yellow-brown. The annual rings are not strongly marked and little, if any, figure is present.

It is remarkable for its strong scent, which is so characteristic that the wood can usually be identified by it alone. Unlike the scent of many other woods, it is very lasting and loses little of its pungency even after a number of years. The scent is reputed to prevent the attacks of clothes' moths when used as a lining for wardrobes.

The texture is compact and the grain usually straight; the surface, which has a decided sheen, tends to exude resin in small streaks, and this makes it of less value for cabinet-making than it otherwise would be. It is fairly hard but light (weighing about 27–30 lbs. a cu. ft. when seasoned).

DURABILITY. It is one of our most durable timbers, even when in the ground. In America the timber has been used for sleepers, is popular for shingles, and the poor qualities for posts, etc.

SEASONING. It normally seasons without trouble.

STRENGTH. Not a very strong timber, although about as hard as Baltic redwood and more resistant to splitting, it is considerably weaker in bending and compression.

WORKABILITY. The gumminess of the timber sometimes makes it somewhat difficult to work, and tools may need frequent resharpening if a reasonably smooth surface is to be obtained. Normally, however, it is easy to work and a good finish is obtainable; it will take a beautiful polish, also stain, paint and varnish. It glues well.

It is stated that, in America, many men cannot work in sawmills where the timber is being converted as it tends to produce kidney trouble.

SIZE and AVAILABILITY. The few plantations of Lawson's cypress are not old enough to furnish timber, so that the small amount available comes from ornamental trees and tends to be somewhat knotty. Sizes of logs vary considerably, but large, clean boles are rare.

USES. Judging from the limited quantity of small sizes home-grown timber so far used, it appears to be of good quality and compares favourably with the well-known imported Port Orford cedar. The wood can therefore be used for most of the same purposes, *e.g.*, battery separators (for which Port Orford cedar is one of the best timbers), joinery, linings of wardrobes and clothes' chests (to prevent the attack of ' moth '), boat and ship building, estate work—posts, rails, fencing, etc.

THE IMPORTED TIMBER

PORT ORFORD CEDAR is the same species as Lawson's cypress, and has been imported into England for a number of years. It is one of the most valuable conifers in N. America.

DOUGLAS FIR

BOTANICAL NAME: *Pseudotsuga taxifolia* (Poir. Rehder., also called *Pseudotsuga Douglasii* Carr.

FAMILY: *Pinaceae*.

COMMON NAMES: Pacific or Green Douglas fir. The very closely allied Colorado Douglas fir, formerly regarded as a variety of Pacific Douglas, is described on p. 83. The imported wood is usually known as British Columbian pine, or Oregon pine.

DISTRIBUTION. Native of Western N. America, from British Columbia south to Mexico. It forms huge forests in the Pacific Coast regions of British Columbia, Washington and Oregon. Introduced into Britain in 1828 by David Douglas, the famous botanist-explorer.

THE TREE. Under the most favourable conditions in this country Douglas fir will grow to a mean height of 110 ft. in 50 years, but as yet the tree has not reached full maturity, so no information is available as to its ultimate height. In its native habitat, Canada and United States, it will sometimes exceed 300 ft. in height with a diameter of 12 ft. and more. When grown in the open the tree is pyramidal in outline and branches very low down, so that its branches often sweep the ground. Even when growing in close forest it retains its branches after they have been killed by the shade, and it is necessary to prune if clean timber is to be obtained.

Douglas fir has been planted very extensively in plantations and is now one of our most common conifers.

Soil and Situation. It prefers a deep, fresh and light soil, but will grow on poor sands and also on clays—although it is very apt to be blown

down in the latter situations. Chalky and limy soils should always be avoided. A high rainfall is very desirable, not less than 40 ins. a year. It needs a sheltered situation, as the leading shoots tend to be malformed or broken by wind; although it is probable that as much damage is done by wood pigeons alighting on the leaders as by the wind. It is not a suitable tree for the east of Britain, but one of the most valuable for the moister and milder parts.

Sylvicultural Characteristics. When grown on deep, light soil the tree is fairly wind-firm, but it is very apt to blow on clays.

It bears a considerable degree of shade and is often used to underplant such species as larch.

It suffers from autumn frosts and care should be taken to avoid planting it in ' frost pockets.'

Douglas fir is one of the fastest growing of our conifers, and for this reason the timber is often coarse. It is therefore advisable to prevent too rapid growth by thinning only lightly and avoiding very rich soils or by growing on a long rotation (100 years or more).

If there is a market for thinnings, Douglas fir may be planted close together (4½ ft. by 4½ ft.) and thinned at 15–25 years, but it would be advisable to plant a shelter belt round the plantation unless it were very sheltered.

The more usual treatment is to plant wide apart, at 6 ft. by 6 ft. or even 8 ft. by 8 ft. and to prune trees selected for the final crop.

Cultivation. Douglas fir is raised only from seed, and this is produced prolifically when the tree is about 25 years old. The young plants are best put out in the forest as 1 yr. 2 yr. transplants, or if the ground is free from weeds, as 1 yr. 1 yr.

Diseases. Of recent years a serious pest has attacked the tree, this is an aphis (*Chermes cooleyi*) which infects the leaves and often seriously restricts growth or kills the tree. It appears to be most prevalent in drier areas and on young trees. No economic cure is known and climates with a fairly heavy rainfall should be selected, where possible, for plantations.

Varieties. The most important is the Fraser River variety (var. *cæsia* (Schwerin) Rehder.). It is an intermediate form between *P. taxifolia* and *P. glauca* (see note on Colorado Douglas fir) and believed to be more hardy than the former.

THE TIMBER. The heartwood of Douglas fir is pale pinkish-brown, darkening with age; the sapwood is clearly marked and is paler and more yellow in colour. The annual rings show a sharp contrast between spring wood and summer wood.

The timber is straight-grained, resinous, and usually coarse in texture, especially the early growth—as the tree ages the rate of growth decreases and the timber is much finer in texture and generally of better quality.

Compared with imported Douglas fir (British Columbian pine or Oregon pine) the home-grown timber is coarser, especially when young, and lighter in weight, being about 31 lbs. per cu. ft. seasoned, compared with 34 lbs. for the imported timber.

When plain sawn there is a characteristic and marked figure due to the strongly marked annual rings (see Plate XX), this zigzag figure is more pronounced in imported timber.

DURABILITY. The heartwood is only moderately durable and the sapwood very liable to decay. Neither should be used in the ground without preservative treatment. Slower-grown material is more durable than fast-grown. The timber (especially the sapwood) is prone to attack by the Furniture beetle.

It does not easily absorb creosote, even under pressure treatment the penetration is very irregular and large sizes need to be incised before creosoting. The wood should be well seasoned before treatment.

SEASONING. The seasoning properties of this timber, both in air drying and kilning, are good. There is a slight tendency for the wood to split and the knots to loosen, but otherwise there is little degrade.

The Forest Products Research Laboratory advise that steaming treatments should be used only sparingly, as these cause the knots to loosen and checks to develop. They also state that the timber is tolerant of high temperatures which are beneficial, as they drive off some of the resin and harden the residue. This helps to prevent the timber ' bleeding ' resin when in use. (Kiln Schedule VII recommended.)

STRENGTH. A moderately strong timber but varies considerably according to the speed of growth; the strongest timber is that having from seven to ten annual rings per inch of radius.

In all respects except hardness and stiffness it is similar to Baltic redwood, but is superior in the two instances mentioned. It is inferior to the imported Douglas fir, except with regard to hardness and resistance to splitting, and in these respects it is about equal. Does not bend easily.

WORKABILITY. Compared with Scots pine, home-grown Douglas fir does not work or finish so well with hand or machine tools, having a tendency to splinter. Conversion from the log is comparatively easy and a reasonably clean-sawn surface is produced.

Although fairly easily worked, care must be taken to use sharp and thin cutting edges in order to eliminate bruising and crushing of the soft

spring wood, as this will otherwise tear out, leaving an uneven surface. It needs care in nailing to prevent splitting ; takes glue and stain well, and if carefully seasoned can be polished, varnished and painted without the grain rising, but it is advisable to use a special primer (*e.g.*, with an aluminium base) if there is any doubt as to condition of seasoning.

SIZE and AVAILABILITY. Previous to the war supplies of home-grown Douglas fir were mostly in the form of fairly small poles which were used in the mines. The larger trees were being left to form large timber, but owing to the needs of the war many of these, together with older plantations and specimen trees, have had to be felled. Logs are available up to 70 ft. long (but only average about 20 ft.) and up to 18 ins. in diameter, although most are not more than 6 ins. Occasionally specimen trees produce even larger logs.

USES. Up to the present it has been used for such rough work as boxes, packing cases, sleepers, pit-props and rough boarding, owing to the fact that imported Douglas fir is of better quality.

The chief disadvantages of this timber are the facts that it is fast-grown and also very knotty. The latter may be eliminated by judicious pruning fairly early in the life of the tree, and by careful sylvicultural treatment during growth, and if these factors can be maintained the timber can be used for general constructional work, joinery, plywood, panelling, etc. Careful conversion and selection should produce material suitable for some of the above uses to-day under present circumstances.

COLORADO (or BLUE) DOUGLAS FIR
(*Pseudotsuga glauca* Mayr.)

At one time this species was regarded only as a variety of the Green Douglas fir (*P. Douglasii* var. *glauca* Mayr.), some botanists still take this view.

The tree is not nearly so valuable as the Green Douglas and should not normally be planted. Although the timber is almost identical, the tree grows very much slower, yielding only a quarter, or less, of the volume increment. It also suffers badly from spring frosts. Its only value is for ornamental planting, as it stands smoke fairly well, and might also be used for underplanting slow-growing species.

The tree may be distinguished by its shorter and bluish needles and resinous buds.

IMPORTED DOUGLAS FIR

Usually known as British Columbian pine, or Oregon pine, the timber is derived from trees of the same species as the home-grown tree.

It is one of the most important structural soft-woods used in this country.

FIR—SILVER

BOTANICAL NAME : *Abies alba* Mill.

Previously the tree was named *Abies pectinata* Lam. and D.C., and this name will often be found in older textbooks.

FAMILY : *Pinaceae.*

COMMON NAMES : Common or European Silver fir, Swiss pine, White deal or Whitewood (in part; most of the whitewood from European countries is composed of common spruce (*Picea Abies*) but a proportion is silver fir). *Note.* Much confusion has arisen over the use of the word 'fir'. It has been used loosely as a general term for all conifers. It may also be used generally for all members of the genus *Abies*, which is a more legitimate use, but it is best to follow the foresters' practice of only using 'fir' with the correct descriptive adjective before it, *e.g.*, Silver fir, Noble fir, Giant fir, etc.

DISTRIBUTION. Silver fir is widely distributed in Central and Southern Europe, reaching as far south as Corsica : it tends to grow mostly in mountainous regions and is found at altitudes up to 6,000 ft. in the Pyrenees. In France, Germany and Switzerland it forms large forests, either pure or as the dominant species.

The tree was introduced into Britain about the beginning of the seventeenth century, and has been grown both as an ornamental tree and in plantations.

THE TREE. Silver fir forms a very large tree : before the introduction of conifers from N. America it was the tallest species in Britain, and is, in fact, the largest of European trees. In this country it reaches 140 ft. and more in height, and 5–6 ft. in diameter under good conditions. In Central Europe trees 200 ft. high are known. A specimen at Aberpergwm, Wales, measured 145 ft. by 13 ft. 3 ins. girth in 1933 (*cf.* 'Welsh Timber Trees,' by Hyde). At Longleat a number of trees contained 300–400 cu. ft. each at 100 years old. The bole is straight and tapering and the branches persist almost to the ground for 40–50 years when close grown, after which they drop off and clear boles of 70 ft. are not uncommon in such older trees. When growing in the open the branches persist almost indefinitely.

When young the tree is of typical conifer shape, *i.e.*, more or less conical ; after about 200 years, however, it becomes flat-topped.

Silver fir was fairly widely planted at one time

but it has been so severely attacked by diseases that other species of *Abies* are now preferred.

Soil and Situation. The tree is one of the few conifers which will endure a heavy clay: it thrives best in a deep moist loam, but will not succeed in very sandy soil. It is better planted on a north or east aspect to prevent the young foliage from appearing too early and being killed by spring frosts.

Sylvicultural Characteristics. It is wind-fast and may be used for shelter belts and will also endure heavy shade from other trees, and is often used to under-plant such trees as oak, Scots pine, larch, etc. Fairly hardy when old but tender when young. An economic rotation is between 80 and 100 years.

Cultivation. Seed is produced every 2–3 years after 65–70 years and should be planted immediately, as it will not germinate if kept from one year to the next. If clean timber is to be obtained, the trees must be planted close together so that the branches are killed; for planting out 2 yr. seedlings or 2 yr. 1 yr. transplants are generally most suitable.

Production of Turpentine. Strasburg turpentine, which is used in varnishes, artists' colours, etc., is obtained from bark blisters and other portions of the tree. From leaves and shoots is distilled an essential oil of turpentine, which is used for medical purposes.

THE TIMBER. It has already been mentioned that silver fir is sometimes mixed with spruce and sold as whitewood. This is made possible because of the very similar appearance of the two timbers.

The timber is white with sometimes a yellowish or pinkish tinge; there is no obvious distinction between heartwood and sapwood. The annual rings are very distinct, and the summer wood more pronounced than in spruce, the knots also are larger and lighter in colour than spruce knots. Forest-grown trees are straight-grained and the texture is smooth and silky although lacking the slight lustre of spruce. It is soft and light in weight (about 30 lbs. a cu. ft. when seasoned, compared with 27 lbs. for spruce and 33 lbs. for Scots pine). The wood is almost free from resin and is odourless.

DURABILITY. The timber is not resistant to decay and should always be treated with a preservative when used in the open or under unfavourable conditions.

Both standing trees and felled logs are favourite breeding places for wood wasps (*Sirex* spp.) the grubs of which bore holes about $\frac{1}{4}$ in. in diameter in the wood. The grub continues to work in the converted timber for $2\frac{1}{2}$–3 years and the mature insect may emerge from wood in a building, etc. The wasps generally attack unhealthy trees and their presence in any numbers in a wood indicates that conditions are unfavourable.

Furniture beetles also attack the wood, especially the sapwood.

The furniture is usually treated with a preservative either by the open-tank method or under pressure, the sapwood especially may be impregnated throughout.

SEASONING. Little trouble is experienced either in air-seasoning or in kilning. Very little warping occurs, but occasional checks develop and knots, when present, may split. (Kiln Schedule VII suggested.)

STRENGTH. Although generally regarded as an inferior timber in all respects to Scots pine and European redwood, it has similar strength properties (although slightly lower), and is actually considerably harder on the end grain.

WORKABILITY. The timber works easily both with machine and hand tools when once seasoned, provided cutting edges are sharp, as the softness of the timber would otherwise produce a bad finish. It may be easily split and takes a good finish, and glues, paints, stains and varnishes satisfactorily. It takes nails well.

SIZE and AVAILABILITY. There are very small amounts of silver fir of any size available in this country: when obtainable, logs are up to 60 ft. long (average 20 ft.) and mostly up to 12 ins. diameter.

USES. Very little home-grown silver fir has been used except for rough estate work. However, good-quality silver fir may be used for building, constructional work, joists, rafters, studding, flooring, etc., also interior joinery (door frames and doors, windows, and staircases).

Care should be taken to select timber of the best quality for constructional work. It is also suitable for the following purposes: Telegraph poles (when creosoted), fencing (when creosoted), sounding boards for musical instruments (specially selected material), carving, wood-wool, boxes—especially for foodstuffs as it does not taint food, pulp and paper (of inferior quality, it is not a first-class pulp wood), firewood—especially kindling, as it splits well and when burned does not throw out sparks.

Other important species of *Abies* in Great Britain are:

GIANT FIR (or GRANDIS)

(*Abies grandis* Lindl.)

A North American species, also called OREGON FIR or WESTERN WHITE FIR on the Pacific Coast, and sometimes LARCH in British Columbia.

THE TREE. In Western N. America it grows up to 300 ft. high and 15 ft. in girth. In this country specimens over 130 ft. high are not uncommon: the maximum height to which it would grow is not known as the tree was only introduced about 1832. It is the fastest-growing tree and produces the heaviest yield of timber of any in Great Britain. In Montgomeryshire, for instance, a grove 50 years old measured 130 ft. in height and was estimated to have 14,000 cu. ft. of timber per acre (*cf.* Hyde's 'Welsh Timber Trees').

The Giant fir succeeds best in a deep moist soil, and in a moist climate it will thrive in heavy clays. It is well suited to many parts of Scotland, where it grows well at altitudes up to 1,200 ft. It is the least tolerant of shade of all the *Abies*, but still comes under the category of 'shade bearers'. It is fairly frost-tender, but wind-firm. A rotation of about 80 years is suitable.

Giant fir is very free from disease (for instance, it is practically immune from *Chermes* attack) and for this reason is preferable to silver fir.

THE TIMBER. The timber is similar to that of silver fir but is rather more yellowish in colour, or may be pale brown. It is soft, rather brittle wood, and is mainly used for boxes and inferior pulp for paper. It can also be used for similar purposes to silver fir. There is extremely little timber available in this country, but the tree is being widely planted and shows promise of being of more value than silver fir, and its timber of better value.

NOBLE FIR

(*Abies nobilis* Lindl.)

The tree is native to North America where it is also known as RED FIR and OREGON LARCH.

THE TREE. In North America it grows to 250 ft. with a girth of 24 ft. First introduced in 1825, there are specimens over 100 ft. high in Britain.

It does well at high elevations, but it is not suited to warmer parts of the country, as it is there liable to attack by *Chermes picea* var. *bouveri*, an insect which attacks the buds and causes swellings round the shoots which ultimately kill the tree. It is a good forest tree for Scotland and similar cold climates. Noble fir has been planted fairly extensively as an ornamental tree, but very few plantations have been formed.

THE TIMBER. The wood is of better quality than silver fir; it is light-yellow to brownish, hard and fairly strong, it is one of the best of the American *Abies*. It may be used for the same purposes as silver fir, but generally for better-class work, *e.g.*, joinery, first-quality food-boxes, etc.

LARCH—EUROPEAN

BOTANICAL NAME: *Larix decidua* Mill., also known as *L. europaea* D.C.

FAMILY: *Pinaceae*.

COMMON NAMES: Common larch, Tyrolese larch.

DISTRIBUTION. Larch is native to the mountainous regions of Central and Southern Europe and is particularly abundant in the Alps, where it forms extensive forests and is found up to the timber line. It is not indigenous to Great Britain, but has been widely planted.

It appears to have been grown in England on a small scale for ornament since the beginning of the seventeenth century, but so little was known about it that when several plants were sent to the Duke of Atholl in about 1728, they were treated as exotics and put in a hot-house, where they wilted so badly that they were thrown on to a rubbish heap; they recovered, and two were planted in the churchyard at Dunkeld, where one still remains (the oldest larch in Britain). The other was destroyed by lightning about 1916. The Dukes of Atholl planted larch after 1728 on a very large scale and were quickly followed by other landowners.

THE TREE. A fairly large tree, it grows to a height of 80–120 ft., occasionally more, and 3–4 ft. in diameter. Trunks may be clear of branches for 60 ft. or more.

The larch is the only important conifer grown in this country which is deciduous; in fact, the only other deciduous conifer of commercial importance is the swamp cypress (*Taxodium*). It is the most valuable and most frequently planted conifer in common cultivation in Britain and also makes one of the best ornamental trees.

Soil and Situation. It will grow on a variety of soils so long as the subsoil is porous. It prefers a deep, fertile, sandy soil, or a deep, porous gravel; drained peat is also suitable and it will even thrive on heavy loam if the subsoil is sufficiently porous. Both very wet or very dry soils are bad.

Larch grows from the timber line (*i.e.*, the highest elevation at which timber trees will grow) down to sea-level in Britain, but being an alpine tree, low elevations and wet soils produce too early spring growth and severe damage by frost often results. For the same reason northern aspects are best.

Sylvicultural Characteristics. Although very wind-firm, larch is not a good tree for shelter belts, as its thin branches and foliage give little protection.

It is the greatest light-demander amongst the conifers grown in this country, and produces so

little shade that the soil is apt to deteriorate underneath, and it may well be underplanted with shade-bearers such as beech, hemlock (*Tsuga heterophylla*), red cedar (*Thuja plicata*), silver fir, etc., or mixed with other light-demanders such as ash or oak. Most plantations are actually pure, and when grown in this way the trees should be planted fairly close : on good soil 5 ft. by 5 ft., and on poorer soil 4 ft. by 4 ft. ; the object should be to let the canopy meet in 8 years (*i.e.*, let the branches of neighbouring trees meet).

Some foresters prefer wide planting, up to 8 ft. by 8 ft., and good timber can be obtained in this way, although there is danger of heavy weed growth and no early thinnings are obtainable. The tree, however, cleans itself well (*i.e.*, the dead lower branches drop off) ; larch plantations are, however, usually ' brushed '—the dead branches knocked off with a pole—to improve the timber.

Larch is very hardy against winter frost and cold, but tender to late spring frosts—it flushes very early. It is one of the slower growing of our conifers, but reaches its maximum height in 40–50 years, and full maturity at about 80 years (which is a good rotation period). First thinnings at 18–20 years are readily saleable.

Cultivation. Larch is raised from seed, which should be sown from mid-March to mid-April ; seedlings are tender and need protection. Planting out in the forest may be done with 2 yr. 1 yr. 1 yr., 2 yr. 1 yr., or even 1 yr. 1 yr. transplants.

Diseases. Larch suffers from a number of diseases, but in most cases they are due to planting in unsuitable soils or situations. The most important is :

Larch Canker. Nearly all European larch plantations are attacked to some degree ; local swellings occur, in the centre of which is a depression often extending almost to the heartwood. Cankers may appear in any part of the stem, and are common in the pole stage of the tree. Japanese larch seldom suffers from canker.

Other diseases include Larch aphis (*Chermes laricis*), and Larch sawfly (*Nematus erichsoni*). Heart rot occurs on bad soils—especially poor sands, and also old arable land, the main cause being the honey fungus (*Armillaria mellea*).

THE TIMBER. Larch is our most valuable home-grown softwood, with the possible exception of yew, and fetches a higher price than any other cultivated conifer.

The heartwood is pale brown to dark red-brown in colour ; the sapwood is yellowish or yellow-brown and fairly narrow even in young trees, it is clearly differentiated from the heartwood.

The wood is normally straight-grained with a rather coarse texture, hard and fairly heavy, weighing about 37 lbs. per cu. ft. when seasoned. It is resinous, but the resin has little or no tendency to exude from the wood once it is seasoned.

DURABILITY. The heartwood of larch is very resistant to decay, and may be used without preservative treatment for fence-posts and other estate and outdoor work. In such cases it will last a number of years without any trouble from decay. The sapwood is not particularly durable and should be avoided for outdoor work unless creosoted.

Logs are apt to be attacked by wood wasp (*Sirex* spp.), the grubs of which may bore in the wood for several years and the mature wasp often emerges after the wood is manufactured and *in situ.* It is possible to hear the grubs working in the wood—which is occasionally the cause of uneasiness if the timber is in a building.

Preservation. Larch is very difficult to impregnate with creosote, even the sapwood is resistant although hot steeping in an open tank (see p. 16) is usually sufficiently effective for small poles. For transmission line poles incising is highly desirable, in fact, almost necessary (see also under ' Uses ').

SEASONING. The timber air-seasons fairly well and quickly, but with some tendency to warp and split. Comparatively large isolated splits are characteristic. Kilning is also fairly easy and rapid, but again, with some tendency to warp. This can, however, be overcome with care. (Kiln Schedule VI recommended.)

STRENGTH. One of the strongest and hardest of the home-grown softwoods, tough and more than half as hard again as Baltic redwood.

WORKABILITY. When converting from the log there is a tendency for the saw to bind owing to the very resinous nature of the wood when green. In felling large diameter larch the saw sometimes binds so badly that it has to be cleaned frequently with turpentine.

When seasoned the wood works fairly easily, although knots are hard and often loose, and tend to blunt cutting edges.

It takes a good finish and can be stained or painted easily. It has good nailing and glueing properties.

SIZE and AVAILABILITY. There is normally a very good supply of larch poles, but large timber is comparatively scarce as the tree is often grown on a short rotation. Usually logs are up to 40 ft.

long (average 20 ft.) and up to 12 ins. or more in diameter (average 6 ins.).

USES. One of the great advantages of larch is that it can be used in almost every stage of its growth, from comparatively small poles to matured trees. This is the reason why it is so widely planted in this country.

Early thinnings (18–20 years old or less) are used for hop poles, rustic work and estate work, such as stakes, light fencing, etc. Later thinnings are valuable for post and rail fences, gates, gate-posts, small scaffolding, and especially pit timber. It is esteemed for pit-props, as it is not only strong and durable, but also gives ample warning before breaking, by bending and cracking loudly. It is also used for mine sleepers.

Mature timber is excellent for the planking of boats and barges, for piling (many of the piles on which Venice is built are of larch), break-waters, weather-boards, flooring, etc. In Scotland it is often used for railway sleepers.

It is *not* suitable for kindling as it throws out a series of sparks when burnt.

Transmission Line Poles. Larger poles may be used for this purpose, but they have a tendency to develop deep splits which may run the entire length of the pole. Also spiral grain is sometimes present and on drying the pole tends to twist and strain the wires. The timber is also difficult to creosote.

The troubles can largely be overcome by incising (*i.e.*, making a large number of shallow incisions all over the pole with a series of blunt blades) before creosoting. This should be done soon after the pole is felled and stripped of bark, when the moisture content is about 25%.

LARCH—JAPANESE

BOTANICAL NAME : *Larix leptolepis* (Sieb. and Zucc.) Murr., also *L. Kaempferi* Sarg. or *L. japonica* Carr.

FAMILY : *Pinaceae*.

DISTRIBUTION. Native to Japan; it was introduced in 1861.

THE TREE. The tree has not been grown in this country long enough to be able to determine its maximum size, but it grows faster than European larch for about the first 25 years, yet probably does not ultimately attain such large dimensions.

Its greatest advantage is its comparative immunity from canker, and for this reason it is being widely planted. It will also succeed in fairly heavy soils, but needs a considerable amount of moisture.

It may be identified by the reddish twigs, those of European larch being straw-coloured.

THE TIMBER. The timber is very similar to that of European larch, but being faster grown it is coarser grained and lighter in weight, averaging not more than 31 lbs. per cu. ft. when seasoned (compared with 37 lbs. for European larch). It also contains more knots, the branches being more persistent.

It is considerably softer, but otherwise has much the same strength properties.

Being softer it works more easily with less tendency to bind on the saw. Sharp cutting edges are, however, necessary to avoid producing a rough surface, due to the soft spring wood plucking out.

SUPPLIES and USES. Supplies are mostly in the form of small poles from thinnings, which are used for similar purposes, to comparable sizes of European larch poles.

LARCH—DUNKELD

(*Larix eurolepis* Henry)

This is a hybrid between the European and Japanese larches. It has only been under cultivation from the beginning of the century, and not sufficient quantities have been planted to provide much data as to its value.

It grows, however, very vigorously ' soon outstripping both parents and being so far free from attacks by *Chermes* and fungi which are so destructive to European larch ' (Dallimore and Jackson).

PINE—CORSICAN

BOTANICAL NAME : *Pinus nigra* var. *calabrica* (Loud.) Schneid.; also *P. Laricio* Poir.

Corsican pine is now regarded as a variety of Austrian pine (*P. nigra* Arnold. See p. 89), which has far less value as a timber tree but is valuable for shelter belts, etc.

FAMILY : *Pinaceae*.

DISTRIBUTION. The tree has a very wide range; from Spain in the west to Greece and Asia Minor in the east. It attains its best development in Corsica, where it sometimes reaches 150 ft. high and 6 ft. in diameter.

It is not native to Britain, but was introduced in 1759 in the belief that it was a maritime form of Scots pine, but was not cultivated to any extent until at least 70 years later.

THE TREE. In Britain the tree grows to 100–120 ft. or more in height, the largest recorded measured 130 ft. in 1924; it was planted in 1828 with four others in Stanage Park, Radnorshire. Diameters of 3 ft. or more are attained.

When grown in the open it retains its branches nearly to ground level and even when grown in close forest does not clean itself readily and may need pruning, but clean boles of 60 ft. are obtainable.

It has been grown extensively during recent years in plantations and as shelter belts, and near the sea-shore.

Soil and Situation. Corsican pine is one of the most useful of conifers for growing on the poorest grades of forest soil. It will succeed on poor sandy types and even on pure sand, also on thin, chalky soils. For its best development a deep, dry, light sandy loam is best, and wet clays should be avoided.

The Forestry Commission have used the tree widely in East Anglia, and for fixing sand dunes on the coast.

A cold wet climate is unsuitable, *e.g.*, North Wales and West Scotland.

Sylvicultural Characteristics. It is very wind-firm and is excellent for sheltering other species. It is a light-demander but will tolerate more shade than Scots pine. Although hardy to frost it is less so than Scots pine and so is less suitable for N.E. Britain (except by the sea).

A fast grower, on suitable soils it will produce about 25% greater volume of timber than Scots pine, sometimes more. In spite of this it is a long-lived tree although it is not economic to grow it on a rotation of more than 80–100 years, and short rotations of 25–35 years may be used to produce mine timber.

Cultivation. The tree is raised from seed. Unfortunately seedlings have weak root systems, as they form a long tap-root with few fibrous rootlets, and the former usually breaks in transplanting. Two-year seedlings or 2 yr. 1 yr. transplants are best for planting out, and this may best be done at fairly wide spacing : 5 ft. by 5 ft. or 6 ft. by 6 ft., although care must be taken to attend to ' beating up ', *i.e.*, replacing plants which die. Closer planting is not necessary, and the early thinnings have little value. Planting is best carried out in early or late September or early April.

Diseases. Pine leaf cast (*Lophodermium pinastri*), a fungus attacking the foliage, especially if heavy weed growth is allowed in early life.

Pine bark beetle (*Myelophilus piniperda*) attacks leading shoots (see under Scots pine).

Rabbits are less troublesome than with many other young trees.

THE TIMBER. The timber is very similar to that of Scots pine : the heartwood is light reddish-brown and generally clearly differentiated from the pale yellowish-white sapwood, which is considerably wider than in Scots pine. It is coarse-grained (due largely to its very rapid growth), fairly soft and light, weighing about 32 lbs. a cu. ft. when seasoned (compared with 33–34 lbs. for Scots pine). It is very resinous and resin canals appear on the end surfaces as small, dark dots, irregularly scattered ; on the longitudinal surfaces as fine, dark lines.

Frequently the timber is knotty, although the knots are usually sound.

It may be distinguished from Scots pine by : (*a*) the wider sapwood, and (*b*) the darker coloured knots.

DURABILITY. Not a naturally durable timber ; the sapwood (which is large) has very little resistance to decay and the heartwood is slightly less durable than that of Scots pine. On the other hand, the sapwood can easily be impregnated throughout with a preservative, and even the heartwood can be more easily treated than Scots pine. Corsican pine is probably the easiest of home-grown softwoods to treat with preservatives.

SEASONING. As there is a strong tendency for the sapwood to ' blue ' (*i.e.*, develop a blue stain), the timber should be loaded into kilns or ' sticked ' in air-seasoning piles as soon as possible after conversion.

Kiln Seasoning. It kiln seasons rapidly and without difficulty or serious degrade (knots will sometimes split). It will tolerate high temperatures, although there is a tendency for some resin to exude, and the wood to darken slightly. (Kiln Schedule VIII recommended.)

Air Seasoning. With this method there is a tendency to stain. To reduce this fault to the minimum the timber is best piled in stick in the spring, or, if in the winter, thicker sticks (1 in.) and narrow piles should be used ; the object of these steps is to speed up the drying, as the ' blueing ' fungus is less likely to infect the timber if drying is rapid.

STRENGTH. A timber of moderate strength, it compares favourably with Baltic redwood and home-grown Scots pine in most strength classes ; it is actually somewhat harder than redwood and, although slightly less strong in other categories, the differences are not sufficiently large to be of any real practical importance.

It tends to be somewhat brittle and cannot be recommended for purposes where shock loads are involved. It is, however, excellent in compression and can be used for pit-props, etc., with confidence.

WORKABILITY. The timber works well with both hand and machine tools, though sharp cutting edges are necessary for really clean work.

The sapwood is slightly more difficult to cut than the heartwood.

In general the timber is very similar to Scots pine, but the knots are usually rather softer and so less liable to tear out in working.

The timber glues and nails well and will take finishes equal to Scots pine.

SIZE and AVAILABILITY. There is a considerable amount of small-sized logs and poles available, but comparatively few large trees. Logs are usually up to 40 ft. long (average 20 ft.) but seldom more than 12 ins. in diameter, often only 6 ins.

Corsican pine timber in the U.K. is all home-grown, none being imported.

USES. The timber can be used for most of the purposes for which Scots pine is generally used; the commonly more knotty timber yielded by Corsican pine make it, however, of less value for better-class joinery. The recent popularity of 'Knotty pine' from Canada as panelling would allow Corsican pine to be used for a similar purpose.

It should be pointed out that the close-grown stands which have been planted of more recent years will undoubtedly produce much cleaner timber in the near future.

Even with the quality of Corsican pine now available the timber can be used very satisfactorily for such purposes as carcasing and general building work; boxes and packing cases; railway sleepers (especially in view of its hardness and the ease with which it absorbs creosote); fences, gates and other estate work, when creosoted.

One of its most important uses is for mining timber, and it could be used more extensively for this purpose; when properly graded it is as good as Scots pine for pit-props.

PINE—AUSTRIAN

BOTANICAL NAME: *Pinus nigra* Arnold.

This tree is far less important from a timber point of view than its variety the Corsican pine. The reason is that it is impossible to prevent the formation of branches almost to the ground, even by close planting. This results in excessively knotty timber, which is also rather more coarse than that of Corsican pine; it is, therefore, almost entirely valueless.

It should be mentioned that Austrian pine is one of the best trees for shelter belts, owing to its persistent branches and great resistance to wind.

PINE—SCOTS

BOTANICAL NAME: *Pinus sylvestris* L.

FAMILY: *Pinaceae.*

COMMON NAMES: When grown in this country this species is almost always called Scots pine (sometimes incorrectly 'Scotch fir' or sometimes 'Common fir').

When imported from North Europe the timber is usually known in commerce as Redwood, Fir, Red or Yellow Deal: also by various names according to its origin, such as Archangel redwood, 'White Sea', 'Baltic', 'Memel', 'Gefle', 'Soderhamn' and 'Norway fir', 'Swedish' and 'Finnish fir', Siberian redwood, etc.

In Scotland the imported timber is known as Red pine.

DISTRIBUTION. The tree has a wider distribution than any other pine. It is found in most parts of Europe and Western and Northern Asia. It is native to Scotland and just over the border into England (the only true pine indigenous to the British Isles). Found growing from Northern Norway, throughout Lapland, Sweden, Finland, Estonia, Latvia, Denmark, Germany, Poland, Czechoslovakia, France, Switzerland and Spain. Also widely distributed throughout Russia and parts of Siberia.

THE TREE. The tree varies from 70–110 ft. in height (rarely more) when mature, with a diameter up to 5 ft., but 30 ins. is seldom exceeded, and very large trees are often rotten in the centre. The bole is usually straight and may be clear of branches for 60–70 ft. The growing tree can be identified by its copper-red coloured bark, which is quite scaly and thin at the upper part of the tree, becoming thick, dark and rough at the base. When young the branches are produced in annual whorls (which give lines of knots at intervals across boards, etc.); with age the tree becomes flat-topped and the lower branches die off.

Scots pine is usually grown on soils too poor for many other species, as it is not a very economic crop, since thinnings have very little value.

Soil and Situation. Scots pine is very accommodating as to soil and will grow on any, except very shallow, very wet or excessively limy soils. It may be planted on drained peats or clays, and thrives best on a deep, well-drained sandy or gravelly loam. The foresters' saying is 'A heather soil is a Scots pine soil'.

It will grow up to 2,000 ft. elevation, but is more successful at lower altitudes; in the former situations a south aspect is best. A valuable attribute is that very young trees will grow in heavy grass, that is fatal to most conifers.

Sylvicultural Characteristics. Although a very wind-firm tree, it is not ideal for shelter belts because, with age, it loses its lower branches. The flattened crown, characteristic of older

trees, renders the tree liable to suffer from snow-break.

It is a strong light-demander and should never be grown under the shade of other species. In close forest it cleans itself of branches fairly well.

An extremely hardy tree, it will even withstand spring frosts. For a conifer it is rather slow growing, but an economic rotation is about 50–80 years.

Cultivation. The tree is raised entirely from seed, which is ideally collected from trees growing in more northerly latitudes than those it is wished to plant.

Natural regeneration is quite successful if rabbits can be kept down. For planting out, 1 yr. 1 yr. or 2 yr. 1 yr. transplants are generally best; these should be planted close, 3½ ft. by 3½ ft. or 4 ft. by 4 ft., in order that the young trees will clean themselves. In this case frequent and light thinnings will be necessary from 10–15 years old, with a result that the very small value of the young thinnings makes the species somewhat costly to cultivate.

Scots pine is usually grown pure, but when possible a mixture of larch is desirable owing to the much higher value of its thinnings. A few beech, sycamore, poplar or birch are also desirable to improve the soil, which otherwise tends to deteriorate.

Diseases. The tree is subject to several diseases, especially when young, *e.g.*:

Pine weevil (*Hylobius abietis*). This feeds on the bark of young trees and may cause widespread loss of trees soon after planting out. It hibernates in the old stumps, and these should be barked; planting should be delayed for a year to avoid the danger.

Pine-shoot beetle (*Myelophilus piniperda*). This bores tunnels up the leading shoots and so kills them; this causes deformation of the tree.

Pine-shoot tortrix moth (*Evetria* (*Tortrix*) *buoliana*). This attacks the leading bud and causes death or malformation of young trees (up to about 15 years old).

Use of Needles. Pine oil is extracted from the needles and used for medicinal purposes. Pine 'leafwool', used as a stuffing material, is also made from leaves.

THE TIMBER. The sapwood is yellowish-white in colour, fairly wide (about 2–4 ins.), but not so wide as in Corsican pine, and usually distinct from the heartwood, which is pale brown or brownish-red. Sometimes the dark colour of the heart only develops after the timber has dried. The wood is fairly resinous, especially the heartwood, and usually straight-grained.

The quality of the timber is affected by the conditions of growth, climate, soil, elevation, etc., more than almost any other timber. These factors affect the texture, density and size and number of knots. As the branches are in whorls the arrangement of knots in horizontal bunches across the boards serve to distinguish pine from larch (in which they are scattered).

Rate of growth is one of the most important factors affecting quality and strength. Often home-grown Scots pine is fast grown, having as little as four to six annual rings per inch of radius, whereas imported Baltic timber may have an average of twenty-five rings or more per inch. According to F.P.R.L. investigations the optimum strength is attained when there are about twelve rings per inch. Slower-grown timber is milder to work (better for joinery, etc.) but less strong; faster-grown timber is coarser, weaker and altogether inferior. The weight is very variable: from 25–45 lbs. per cu. ft. when seasoned, but is generally about 33 lbs.

DURABILITY. The heartwood is moderately durable but the sapwood has little resistance to decay. When green logs may be attacked by wood wasps (*Sirex* spp.) which, if not killed during conversion and seasoning, may emerge from timber when in use. Longicorn beetles and pin-hole borers are also sometimes found in green timber. Seasoned wood is mainly attacked by the Furniture beetle.

The sapwood absorbs creosote avidly and can easily be impregnated throughout; the heartwood is moderately resistant, but less so than Douglas fir, and does not usually need incising to obtain even penetration, but it is necessary to use pressure methods.

Pressure-creosoted Scots pine poles used by the Post Office for telegraph poles are reckoned to last up to 70 years.

SEASONING. The timber seasons rapidly and without difficulty either by kilns or air-seasoning methods. There is, however, a strong tendency for the sapwood to become discoloured (by 'blueing', see p. 14). To minimise this trouble the timber should be put into stick immediately after breaking down on the saw, and the boards kept well spaced with 1-in. stickers; the stacks should also be narrow.

Very little degrade occurs during seasoning, even when fairly high temperatures are used in the kiln. (Kiln Schedule VIII recommended.)

STRENGTH. It has already been mentioned that locality, rate of growth, etc., affects the strength properties very considerably, but generally the timber is strong for its weight and moderately hard. Maximum strength is obtained in timber having about twelve rings per inch.

It compares favourably with Baltic red-

wood, being generally somewhat harder and tougher.

WORKABILITY. The timber works fairly easily with most hand and machine tools; faster-grown material needs greater care and sharp, thin cutting edges are necessary to avoid tearing the rather wide, soft spring wood, and knots may also give trouble.

It nails well, takes glue, and may be painted, polished or varnished easily. It veneers well if clean and fairly slowly grown, and could be used for plywood.

SIZE and AVAILABILITY. There are fairly abundant supplies, especially of small sizes; a considerable proportion of the larger trees in the old forest areas of Scotland have been felled during the war. Very large areas have been planted by the Forestry Commission since 1919, and these should ultimately provide a good source of supply.

Logs are generally up to 35 ft. long, but occasionally up to 75 ft.; these old trees may be 3 ft. in diameter, but a normal maximum is about 15 ins.

USES. Good quality Scots pine, of slow growth, is quite equal to Baltic redwood and may be used for similar purposes. Unfortunately, much of the home-grown timber is too rapidly grown and very knotty; such timber can only be used for rough estate work, boxes, etc. The best quality may be used for structural work, including all kinds of building work: rough carcassing, joists, rafters, flooring, doors, window frames, stairs, matchboarding, and all types of joinery.

At present the commonest use of Scots pine is for pit-props and other mine timber, and it is also frequently used for: sleepers, box shooks, crates, slack cooperage (barrel staves and heads), such estate purposes (when creosoted) as fencing, sheep hurdles, gates and gate-posts, etc.; it is also cut into thick veneers, which are made into baskets.

Good-sized poles are accepted by the Post Office for telegraph poles; these are divided into three classes:

Extra Light and Light Poles. 18–50 ft. long and 4–7 ins. top diameter.

Medium Poles. 24–70 ft. long and $5\frac{1}{2}$–$9\frac{1}{4}$ ins. top diameter.

Stout Poles. 28–85 ft. long and $7\frac{1}{2}$–$10\frac{1}{2}$ ins. top diameter.

Poles must contain the natural butt (trees must be cut as close to the ground as possible) in order that there is no possibility of heart-rot being present and passing undetected.

Immediately prior to the war between 11,000 and 15,000 Scot pine (home-grown) were being used by the Post Office every year for telegraph poles.

SEQUOIA
(CALIFORNIAN REDWOOD)

BOTANICAL NAME. *Sequoia sempervirens* (Lamb.) Endl.

FAMILY: *Pinaceae.*

COMMON NAMES: Sequoia, Coastal redwood.

DISTRIBUTION. It is native to California and S. Oregon, where it is limited to a belt near the coast, not more than 20 miles wide. It was introduced into Britain about 1843–6.

THE TREE. This species provides the tallest trees in the world. In its natural habitat specimens up to 375 ft. are known, although not attaining so great a diameter as the closely related Wellingtonia (q.v.), diameters of 20 ft. and more are known. The age of the largest trees is reckoned to be 1,500 years or more.

It has not been grown long enough in this country to determine its maximum dimensions here, but there are many specimens over 100 ft. high. Apart from one or two small plantations, this species has been planted only as an ornamental tree, but in recent years the Forestry Commission has planted it to a small extent in Wales and one or two private landowners are also beginning to plant it as a forest tree. The form of the tree is conical and the trunk tapers considerably. It may be distinguished from Wellingtonia in having projecting leaves similar to those of yew, whereas Wellingtonia has scale-like leaves. The bark is fibrous, very soft and thick.

Soil and Situation. The tree needs a deep, rather light and permeable soil to thrive well, also a mild climate and a fairly sheltered position. Moist, sheltered valleys having a good depth of soil, as found in parts of S. Wales, for instance, are ideal.

Sylvicultural Characteristics. It is a very wind-firm tree, and, like the Wellingtonia, may be grown round the outside of a plantation as shelter; it would not, however, be suitable if the situation were too bleak and exposed.

Fairly frost-hardy, it is sometimes damaged by early frosts, especially if growing under good conditions, which induce the tree to continue growing late into the autumn.

It is a light-demander and a very rapid grower; Ackers (27) states that a grove of these trees at Leighton in Montgomeryshire has been estimated to contain some 19,000 cu. ft. per acre at 75 years old. This figure represents a higher yield than any other tree of the same age in this country.

The thick fibrous bark is an excellent protection against forest fires, and older trees are almost indestructible from this cause.

Redwood could well be planted on a commercial scale as it is suitable to this country, produces a heavy yield of good quality timber, is hardy and almost immune from fire and disease.

Cultivation. Trees may be raised from seed, in which case the young plants need protection against frost, and, being somewhat difficult to transplant, are best established as 1-year transplants.

Redwood has the rare property amongst conifers of coppicing readily and it may be treated in this way to produce poles, or shoots for layering. Cuttings will also root easily, but some authorities claim that the best trees are always raised from seed.

Diseases. In Britain the tree has been, so far, entirely free from disease.

Use of Bark. In America the bark has been used recently (during the war) as a raw material to form cloth, and various types of clothing, hats, etc., have been made from it.

THE TIMBER. The heartwood is fairly dark brownish-red and sharply differentiated from the yellowish-white sapwood. The grain is usually straight but the texture often coarse owing to the rapid growth of the tree; as with most introduced conifers, the quality of the wood could be greatly improved if the rate of growth were controlled by suitable sylvicultural methods.

It is soft, softer than most conifers (with the exception of *Thuja plicata*), and light in weight, varying from 24–29 lbs. per cu. ft. when seasoned.

Burrs are sometimes found, and these provide beautifully figured timber.

DURABILITY. Sequoia is one of the most durable of conifers, home-grown timber has lasted for 20 years in the ground with no sign of decay, although untreated.

It is resistant to acids and one of the best timbers for vats containing sulphuric and other acids.

In California trees have lain on the forest floor (after being blown down) for periods as long as 2,500 years and have still been sound and cut into good quality timber.

SEASONING. It appears to season with little degrade and when once dried is extremely stable, moving hardly at all even under adverse conditions, *e.g.*, near fires and radiators.

STRENGTH. For its weight the timber is moderately strong, but is weaker than Scots pine, for instance, but considerably stronger than red cedar (*Thuja plicata*) with which it is usually compared, the two timbers being very similar in appearance and most properties.

WORKABILITY. Owing to its softness it is necessary to use sharp, thin-edged tools, and there is a tendency for the timber to blunt them. A good smooth finish can, however, be obtained.

SIZE and AVAILABILITY. Only a very small supply of home-grown timber is available as the tree has been planted almost entirely for ornamental purposes, but recent planting on a commercial scale will provide much larger quantities in the future. Logs are up to 40 ft. long (but usually very knotty) and 2–3 ft. diameter at the base, but tapering rather sharply.

USES. The timber available at present is mostly too fast grown and too knotty to be used for more important purposes than rough estate work—fences, stakes, rough weather-boarding, etc. The good quality timber that is available is valuable for :

Tanks and vats in breweries, wineries, distilleries, pulp and paper mills, chemical plants and food products plants (brine processing, etc.).

Structural work in houses and even heavy construction, including farm buildings (silos, barns, pig-houses, etc.).

Joinery and interior decorations (excellent for panelling, doors, built-in furniture, etc., as it shrinks hardly at all).

Weather-boards and shingles.

Coppice poles may be used for fence posts, rustic work, pergolas, etc., and might well compete with larch thinnings for such purposes, as they are raised more quickly and easily.

SEQUOIA
(WELLINGTONIA)

BOTANICAL NAME : *Sequoia Wellingtonia* Seem. Also known as *S. gigantea* Decne. A separate genus has been formed for this species and the name *Sequoiadendron giganteum* (Lindl.) Bucholz. is used.

FAMILY : *Pinaceae.*

COMMON NAMES : Sequoia, Mammoth Tree, Big Tree, Giant Redwood.

DISTRIBUTION. The tree is native to a very limited area in California, forming groves on the western slopes of the Sierra Nevada at altitudes of 4,300–8,000 ft. The seed was introduced into Britain in 1853 and the tree has been widely planted for ornamental purposes.

THE TREE. The Wellingtonia has been described as the largest and oldest living thing known in the world. In California specimens are known 320 ft. high and 30 ft. in diameter above the buttressed base and containing up to 50,000

cu. ft. of timber. The trunk may be clear of branches for 150 ft. or more and the bark is often 1–2 ft. thick. There is some doubt as to the age of the very large trees but some are believed to be as much as 4,000 years old.

In Britain it has only been planted for ornament and has not been in cultivation long enough to determine what size it will ultimately attain, but specimens over 100 ft. high and up to 5 ft. in diameter are fairly common. As the trees are mostly grown in the open as avenues, etc., the branches usually descend almost to the ground. In a few instances it has been grown in forest and then has produced straight, clean stems with comparatively little taper.

Soil and Situation. The tree grows best in a good, deep, moist soil, a sheltered situation and a climate with a fairly heavy rainfall; it is more suited to the West of England than the East.

Sylvicultural Characteristics. It is very wind-firm and may be used as a shelter round the outside of plantations, etc.

It is a light-demander, fairly hardy against frost even in Scotland and a rapid grower (putting on 1–2 ft. in height a year under favourable conditions and 1–1½ ins. diameter). With such rapid growth the timber is too coarse to be of much value, but it would probably pay to grow trees close together and thin lightly to reduce the rate of growth. On the other hand, it seems likely that the closely related *Sequoia sempervirens* is more worth while planting.

Cultivation. Unlike *S. sempervirens* this species will not shoot from a stump, but may be raised either from seed (although young trees tend to die off), from cuttings or layers. If transplants are used, 2 yr. 2 yr. are best.

THE TIMBER. The timber is so similar both in appearance and properties to *Sequoia sempervirens* that a separate description is unnecessary. It differs from the latter timber in being slightly darker, more brittle and somewhat more difficult to work; it is thus obviously less valuable, but useful for most of the same purposes except where higher stresses are involved.

SPRUCE—COMMON

BOTANICAL NAME: *Picea Abies* (L.) Karst.

FAMILY: *Pinaceae.*

COMMON NAMES: In Britain the tree and timber are known as Spruce or Common or Norway Spruce. The timber from the same species imported from the Baltic countries is called whitewood, white deal, fir, white fir, and in Scotland white pine.

DISTRIBUTION. A native of Europe (especially the mountainous regions) it has a very wide range, from the Urals and Lapland to the Pyrenees and Alps, reaching an altitude of 6,000 ft. The trees are gradually encroaching on the pine forests in a westerly direction. There is no record of the date when spruce was introduced into England, but it is known to have been cultivated for about 400 years—certainly before 1548.

THE TREE. Under favourable conditions the tree attains very large sizes, up to 120 ft. in height and 4 ft. in diameter, but is usually not more than 80 ft. In Central Europe heights of 200 ft. are reached, but in N. Europe it seldom exceeds 50–60 ft. at 100 years old or 80 ft. at 200 years.

When grown in close forest stems may be free from branches for up to 60–70 ft.; in the open the tree retains its branches almost to the ground.

Spruce is one of our most widely planted conifers and is well known as the 'Christmas tree.'

Soil and Situation. Spruce is very useful for planting in poor, damp, thin soils and on colder mountain soils and other exposed places, where more valuable trees will not grow. It needs, however, a more fertile and moist soil than most of the pines and succeeds best on moist loams, but will thrive on sands if sufficiently moist, and also on clays.

Land growing grass or rushes is suitable but peat soils bearing heather tend to poison spruce trees.

North and east aspects are most suitable.

Sylvicultural Characteristics. Spruce is the least wind-firm of our forest trees when grown in woods, but in the open is fairly firm. This is due to the shallow-root system which has not sufficient room to spread under forest conditions, but when unrestricted can develop a very wide plate-like root system that is not easily disturbed (known as 'anchor roots').

Being a shade-bearer it tends to retain its lower branches unless planted fairly closely together and carefully thinned. Although usually planted pure there is a danger that the humus formed by the fallen needles will remain undecayed and render the soil acid. This checks the growth and may cause the death of a proportion of the plantation. For this reason it is always advisable to mix groups of broad-leaf trees, such as beech, with spruce.

It is moderately frost-hardy, but may be damaged by late spring frosts. However, it is more hardy than Sitka spruce and so may hold its own against the latter far more valuable species.

When young the growth is slow but after

about 10 years it increases very rapidly and an economic rotation is from 40–70 years.

The mature timber is of less value than Scots pine but of greater bulk per acre, also the thinnings are more valuable (being straighter).

Cultivation. Raised entirely from seed. For planting out 2 yr. 2 yr. transplants are usually best, but 2 yr. 1 yr. or 2 yr. seedlings may be used if of very vigorous growth.

Diseases. Spruce suffers from a number of diseases, the commonest of which is the spruce aphis (*Chermes abietis*) that forms galls on the twigs and spends part of its life-cycle on the larch.

Varieties. There are a large number of ornamental varieties of spruce, and these are divided into groups: (*a*) *Dwarf varieties, e.g.*, var. *Clanbrasiliana* Th. Fries, a low, dense type, seldom growing more than 3 ft. in 30 years. (*b*) *Pendulous varieties, e.g.*, var. *inversa* Nash B. and var. *pendula* Nash K. (*c*) *Varieties having different leaves and habits, e.g.*, var. *argenteospica* Hesse, the young shoots creamy white.

Christmas Trees. If carefully grown, young trees can be very profitable as Christmas trees, but they must be of good shape. Plants will take 4–5 years to grow 1 ft. in height and about 8 years to reach 2–3 ft.

Burgundy Pitch. Resin may be extracted by tapping the trees; on purification the resin may be used both for medicinal purposes and in varnishes. Tapping has, so far, been carried on only in Scandinavia and Central Europe.

THE TIMBER. The wood is white to pale buff in colour with little or no distinction between sapwood and heartwood, especially when the timber is seasoned. It is extremely difficult to distinguish spruce from the sapwood of Scots pine if no knots are present.

Like Scots pine, the quality of the timber is greatly influenced by soil and situation, some authorities stating that trees grown on thin, dry soils produce timber that is more brittle than those grown on good deep loam. There have been, however, no actual scientific tests to prove this view. Slow-grown timber is better for working, gives less trouble seasoning and is finer in texture.

The grain is usually straight, even, and the surface shows a slight lustre. It is fairly soft and light, weighing about 27 lbs. per cu. ft. when seasoned.

The timber is very similar in all ways to imported whitewood.

DURABILITY. Spruce is not resistant to decay in the open or under adverse conditions; it is less durable than Scots pine (heartwood). Logs may be attacked by wood wasps (*Sirex* spp.) and sawn timber (especially the sapwood) by Furniture beetle.

Occasionally the wood is found to be stained reddish-brown and slightly soft in the discoloured area, this is due to attack by a fungus (*Stereum sanguinolentum*) sometimes called red-rot or included under the general term ' doat '.

Preservation. The timber, even the sapwood, is resistant to the penetration of preservatives and pressure treatment is necessary for really reliable results. It has been found that poles—to be used for fence posts, etc.—are best seasoned before treatment, but even so the butt-tank method is variable in its results. Even penetration is obtainable, but only where the timber is free from knots.

SEASONING. The timber air-seasons fairly rapidly with some tendency to warp, very careful stacking is necessary to overcome this defect, some checking may occur and knots tend to split and fall out. Converted timber should be put ' into stick ' immediately off the saw, or there is a danger of bad staining of the sapwood.

It kiln-seasons quickly and well and with little degrade—apart from loosening and splitting of knots. (Kiln Schedule VI suggested.)

Shrinkage during drying is small, less than Scots pine.

STRENGTH. A fairly tough and elastic timber, it has almost the same properties as Baltic redwood, in spite of its lighter weight.

WORKABILITY. The main difficulty in working spruce is due to the presence of small, very hard dead knots, which are often loose; these are troublesome in planing and sawing and make the timber almost impossible to veneer. Clear timber is fairly easy to work and finishes well. It has good nailing and glueing properties, and takes stain, paint or varnish well. There is some tendency for logs to bind on the saw when breaking down.

SIZE and AVAILABILITY. There is a fairly good supply of small timber available, but comparatively little of large sizes. Logs may be up to 40 ft. long, but the average is about 20 ft., diameters are generally from 6–12 ins., but occasional trees may be up to 3 ft.

USES. Home-grown spruce has not been widely used, since only comparatively small sizes have been available in any quantity. Poles from thinnings, etc., have been mainly used for pit-props, and general estate work (fence posts, etc.), and to a smaller extent for wood-wool and pulp. As existing plantations mature the timber will become far more important and of the better quality.

The most important uses of spruce are as follows : boxes, especially food containers, as it does not contaminate foodstuffs, slack cooperage, wood pulp for paper, rayon, etc. (although Sitka spruce would be more economic as it produces a heavier yield), ladder sides, scaffold poles, interior joinery, furniture, if painted or built-in, especially table tops in dairies and kitchens, owing to its clean white appearance and because it may be washed or scrubbed, structural work in house-building (whitewood is largely used in the North of England and Scotland for this purpose), sleepers, spares for ships and boats, violins, 'cellos and other musical instruments (carefully selected, slow-grown material).

SPRUCE—SITKA

BOTANICAL NAME : *Picea sitchensis* (Bong.) Carr.

FAMILY : *Pinaceae.*

COMMON NAMES : In Britain the tree is known only as Sitka spruce, but the imported timber is also called Silver or Aeroplane spruce. In N. America such names are used as Tideland spruce, Western spruce or Menzies spruce (this in honour of Menzies, who discovered the tree in 1792).

DISTRIBUTION. It is native to the coastal regions of Western Canada and U.S.A., from Northern California through British Columbia and Queen Charlotte Isles to Alaska. It grows further north than any other American conifer. Introduced into Britain in 1831.

THE TREE. Specimens of 120 ft. in height are known and with diameters up to 5 ft., but the tree has not been cultivated long enough to determine its maximum dimensions. In N. America heights of 150–200 ft. are known and diameters of 12 ft. or more.

The trunk has little taper, and when the trees are close grown may be clear of branches for 40 ft. or more. Sitka differs from common spruce in having silvery foliage and sharp pointed needles (which make it entirely unsuitable for Christmas trees).

H.M. Forestry Commission have planted considerable areas during recent years as a future source of pit wood. There are also a number of older park trees which are highly ornamental.

Soil and Situation. Sitka will grow in a wide variety of soils and situations, from sea-level in the South of England to altitudes of 1,500 ft. in Western Scotland. At high altitudes it is probably our most valuable tree.

It will thrive on most soils that are fairly deep and not too dry and sandy; it is extremely useful for stiff clays and boggy ground (*e.g.*, peat bogs in Wales). It needs a fair amount of moisture and succeeds best in a moist, clayey loam and with a rainfall of 40–50 ins.

Sylvicultural Characteristics. This tree is wind-firm and a moderate shade-bearer. It is rather tender to frost, especially in the spring. Frost-pockets should be avoided when planting.

Sitka is one of our most rapidly growing trees; under good conditions it will produce annual leading shoots 4–5 ft. long. The Forestry Commission 'Yield Tables' show that it produces a greater volume of timber per acre than any other conifer for which data is available and under present sylvicultural conditions. At 50 years old quality Class 1 Sitka has a mean height of 100 ft. and a volume of 9,350 cu. ft. per acre; the corresponding yields of Douglas fir is 7,900 cu. ft., common spruce is 6,769 cu. ft., and Scots pine is 3,530 cu. ft.

Cultivation. Always raised from seed; cuttings will, however, strike.

For planting out 2 yr. 2 yr. or 2 yr. 1 yr. transplants are best, 2 yr. seedlings may be used if of good size.

It is usually planted pure, but may be mixed with larch, for instance, and with a broad-leaf species such as beech or sycamore, to improve the soil. Most foresters plant fairly close, 4 ft. by 4 ft and 4½ ft. by 4½ ft., but wider planting (up to 6 ft. by 6 ft.) has been advocated on good soil.

Diseases. Some damage is caused by *Chermes Cooleyi*, an aphis which has part of its life-cycle on Douglas fir and part on Sitka spruce. Young trees are sometimes killed and older ones 'pumped' (*i.e.*, suffer from heart-rot) by the honey fungus (*Armillarea mellea*).

Damage by rabbits is far less severe than with common spruce, due to the very prickly foliage.

The long leading shoots of young trees (up to about 25 years) are sometimes broken by pigeons alighting on them, this is not so serious as with most other conifers, as the leader is quickly replaced and the trunk does not suffer in straightness.

THE TIMBER. Sitka spruce is very similar in appearance to common spruce, being white to pale buff in colour and with no obvious difference between heartwood and sapwood, sometimes the former is slightly pinkish (a point of identification).

The grain is usually straight, although occasionally spiral, the planed surface is slightly lustrous.

The wood is soft and light, weighing about 25 lbs. per cu. ft. when seasoned, compared with an average of 27 lbs. for common spruce. It can

usually be distinguished from the last-named timber by the wider annual rings.

As with other home-grown softwoods, there are no trees sufficiently old and slowly grown to provide timber which can fairly be compared with that imported from Canada. There is no reason to believe, however, that equally good timber cannot be grown with correct sylvicultural methods and a long rotation.

DURABILITY. Not resistant to decay and apt to be attacked by Furniture beetles when seasoned. Wood wasps also attack the log. It is somewhat more resistant to the impregnation of preservatives than common spruce.

SEASONING. It seasons fairly well and rapidly both in the open or in kilns, but with a tendency to warp and split, especially timber from small trees.

STRENGTH. A fairly strong timber for its weight, but F.P.R.L. figures show it to be slightly inferior to common spruce in all categories except hardness, in which it is superior. It is usually considerably weaker than the imported timber.

WORKABILITY. Similar to common spruce. Clean timber works fairly well, but knots are very hard and often loose and cause trouble in planing. Very sharp tools are necessary to obtain a good finish as it is rather more woolly to work than common spruce.

SIZE and AVAILABILITY. Occasional large logs are obtainable, but mostly only small and medium sized poles are available. Logs are normally up to 40 ft. long (average 20 ft.) and 12 ins. in diameter (average 6–8 ins.).

USES. As for common spruce but more suitable for tent and scaffold poles and ladder sides, as small trees are usually straighter and have less taper.

It is the best home-grown timber for pulp, being superior to common spruce in being faster-grown and so having a heavier yield per acre.

YEW

BOTANICAL NAME : *Taxus baccata* L.

FAMILY : *Taxaceae.*

COMMON NAME : Common or English yew.

DISTRIBUTION. The yew is native to most parts of Europe and extends into Western Asia and North Africa and is even found on the Himalayas at elevations of 6,000–11,000 ft. It is one of the three conifers indigenous to Britain ; the other two are Scots pine and Juniper.

THE TREE. A fairly short tree, it seldom exceeds 60 ft. in height and is generally not more than 30–40 ft. When old the bole is massive—7 ft. or more in diameter—but short and nearly always deeply fluted ; this is due to the trunk being frequently formed by a number of vertical stems which have fused together. Naturally, such a bole does not yield a large quantity of clean timber, although enormous diameters are reached. Specimens 20 ft. across are known.

Yew is one of our commonest and best-known conifers, it is frequently seen in churchyards, where it was planted, in many cases hundreds of years ago, because of its sombre appearance. It is also found scattered in woods of broad-leaf trees and only in rare instances in pine plantations or woods. Probably its most common use is for hedges in gardens or parks, it is excellent for this purpose as it may be clipped without injury for an indefinite time and makes complete screen down to the ground. It is the commonest tree for topiary work.

It is not suitable for hedging on a farm as the foliage (also the bark) is usually poisonous to cattle. There is great variation in its effect on cattle, some even appearing to be immune. Clippings of foliage that are partly withered appear to be most poisonous.

Soil and Situation. Yew is very accommodating as to soil and will grow on almost any that is not too dry and sandy. It prefers a chalky or limestone soil.

On shallow soils it is often bushy. It thrives in most parts of Britain with little regard to climate.

Sylvicultural Characteristics. The tree is very wind-firm and will grow in all but the densest shade, being often the only plant found in a pure beech wood. It will only produce a good shape if grown with some overhead light ; the best boles for timber are those formed in pure plantations of yew.

It is very hardy against frost. As it is very slow growing it is necessary to use a long rotation —at least 100 years, and it would certainly be worth growing in pure plantations even on a 200-year rotation. Yew lives for a great number of years and exceeds the oak in longevity, historic specimens are probably more than a thousand years old.

Cultivation. Yew is generally raised from seed, but cuttings may be used. The seed (or ripe fruit) should be kept for a year, mixed with sand or soil which is turned over occasionally before planting. Two-yr. 2 yr. transplants are suitable for planting out.

Varieties. There are a very large number of garden varieties of yew ; two of the commonest are ' Golden yew ' (var. *aurea*) and the Irish or Florence Court yew (var. *fastigiata*), the latter

columnar in shape with vertical branches springing almost from ground-level, and a flattened top; it can only be propagated from cuttings of female trees.

THE TIMBER. The heartwood is reddish when first cut, becoming deep brown on exposure to the air, or may occasionally be somewhat yellowish-brown with dark streaks. The sapwood is very narrow, white in colour and sharply demarcated, but with usually a narrow grey zone at the junction with the heartwood. The texture is very fine; the growth rings usually close together (indicating slow growth) and appear as dark fine lines which give the timber its characteristic and beautiful grain.

Owing to the fluted trunk and the general irregular habit of growth, the timber frequently has a wavy grain which is extremely valuable for decorative work.

Yew is by far the hardest and heaviest of our home-grown softwoods, weighing about 42 lbs. per cu. ft. when seasoned. Occasionally burrs of yew are found, and these have a high decorative value and are usually cut into veneers.

DURABILITY. Yew is well known for its high resistance to decay. Fences and posts which have been in service for 20 years have shown no signs of decay. In many parts of the country it is a common saying that a post of yew outlives a post of iron.

It is not immune to the attack of the Furniture beetle, but, as usually the sapwood only is affected, this is not serious. Yew has high fire-resistant properties.

SEASONING. The timber air-seasons satisfactorily though slowly, with some tendency for any existing cracks to open. It kiln-seasons well and rapidly, and shrinks comparatively little during seasoning. (Kiln Schedule II recommended.)

STRENGTH. Yew is a tough resilient timber, practically as hard as oak and resistant to splitting.

WORKABILITY. The timber works fairly easily with most tools, but has some tendency to bind on the saw. Straight-grained material obviously works better, especially in the planing machines, than the curly-grained timber that is frequently found. It is an excellent turnery wood and is frequently used for the manufacture of bowls, etc. It also veneers well. A very fine finish can be obtained, and when french polished the timber is one of the most beautiful of all woods.

SIZE and AVAILABILITY. As mentioned above, there are a number of small yew trees, many of which are badly shaped, but sufficient containing good timber to provide a reasonably good supply. The commercial sizes of sawn timber generally available are 1–6 ins. in thickness by 6–12 ins. in width and of lengths up to 10 ft.

USES. Many years ago the most famous use for yew was for the bows of archers. It was also widely employed for furniture, such as parts of wheel-back chairs, panelling, flooring, etc. In recent years yew has been somewhat overlooked except for small turned articles for domestic use, and very occasionally for furniture.

There is no doubt that yew is one of the most attractive of timbers, and although it is difficult to obtain large sizes there is no reason why it should not be used to a very much greater extent than it has been. There are sufficient yew trees in the country to provide large enough sawn timber for the much wider manufacture of yew furniture and also to provide veneers for furniture panelling and other interior decoration.

CHAPTER VIII

SOFTWOODS OF MINOR IMPORTANCE

CRYPTOMERIA

BOTANICAL NAME: *Cryptomeria japonica* (L.f.) D. Don.

FAMILY: *Pinaceae.*

OTHER NAMES: Japanese cedar or Sugi (the usual name in Japan).

DISTRIBUTION. Native to China and Japan; about 30% of the total forests of Japan are composed of cryptomeria.

Introduced into Britain in 1842.

THE TREE. In Japan the tree reaches 120–150 ft. in height and 5–7 ft. in diameter. It has not been grown sufficient time in Britain to determine its ultimate dimensions, but there are many examples up to 80 ft. high and 2 ft. to 2 ft. 6 ins. in diameter.

It is a very ornamental tree, with a conical crown and tapering, buttressed trunk. So far it has not succeeded well enough to make it worth

planting as a forest tree, but it is a common garden and park tree.

Abundant rainfall and a good, deep, moist soil are desirable for good growth; hard, dry soils and exposed situations should be avoided (although it is fairly wind-firm). It will thrive in all but the coldest parts of Britain. It is fairly hardy against frost. In Japan it is grown on rotations varying from 60–120 years. Cultivation is by seed, and for planting out 2 yr. 2 yr. transplants are generally most suitable.

THE TIMBER. The sapwood is white to yellowish, and the heartwood reddish. The timber is sometimes handsomely figured and it has a fragrant scent. The texture is variable, usually rather coarse, and generally the wood resembles sequoia in both texture and colour. The wood is soft and light, weighing about 22–25 lbs. per cu. ft., when seasoned.

DURABILITY. A very durable timber, even when used in the open; it is also not readily attacked by insects.

SEASONING. Little difficulty is usually experienced in seasoning.

STRENGTH. Although fairly strong for its weight, cryptomeria is not used for constructional work in this country, largely owing to the limited supplies available.

WORKABILITY. Easy to work, but a tendency to 'pluck'.

SIZE and AVAILABILITY. Occasional stems from trees grown in avenues, parks, etc., are available, and logs may be up to 16 ft. long and 2 ft. in diameter. The supply is, however, very limited.

USES. Cryptomeria is one of the most widely used timbers in Japan for such purposes as building construction, joinery, panelling, furniture, boxes, etc. Good-sized, clean logs of home-grown timber could be used for similar purposes.

CYPRESS—MONTEREY

BOTANICAL NAME: *Cupressus macrocarpa*. Hartw.

FAMILY: *Cupressaceae*.

OTHER NAMES: Known to gardeners as Macrocarpa.

DISTRIBUTION. Only native to a very small coastal area in Monterey and the island of Guadaloupe. It has been planted successfully in Australia, New Zealand, South and East Africa. Introduced into Britain about 1838.

THE TREE. In this country the tree grows to 80 ft. or more and 3 ft. or more in diameter (in California boles may be 6 ft. across). Older trees become flat-topped, resembling Cedar of Lebanon, when they tend to suffer from snow-break. As an ornamental tree, and also as a hedge, Monterey cypress has been planted extensively in the S. and S.W. counties of England. It is suitable for situations near the sea and is adaptable as to soil, thriving on even clayey and chalky soils. It is not very hardy and should only be planted in the warmer parts of the country; neither is it wind-firm, so that exposed positions should be avoided. It will endure a certain degree of shade and may be used for under-planting.

The tree may be raised from seed, but young plants are difficult to transplant and are best established in their permanent positions as 1 yr. seedlings (this makes the tree rather unsuitable for forestry work).

Perhaps the best method of growing is both to raise the seedlings and plant them out in flower pots, cracking the latter before planting in the final site. Cuttings also will strike. A rotation of 50–60 years would probably be most economic.

TIMBER. The wood is yellowish to brownish-yellow, with little demarkation between sapwood and heartwood. It has a dull surface, and a pleasant, spicy scent; straight-grained, soft, and weighs about 28–30 lbs. per cu. ft. when seasoned.

Generally speaking, the timber is of good quality, but too knotty for good-class work.

DURABILITY. Fairly durable.

SEASONING. Moderately easy to season.

STRENGTH. Comparable in strength with Western hemlock.

WORKABILITY. Easy to work unless excessively knotty. It takes nails well and glues satisfactorily.

SIZE and AVAILABILITY. Very little timber of any useful size available, being mostly planted as a hedge or for ornamental purposes.

USES. When fairly free from knots the timber may be used for furniture, clothes' chests, joinery, etc. Knotty timber is suitable for estate work, fencing, etc.

CYPRESS—YELLOW

BOTANICAL NAME: *Chamæcyparis nootkatensis* (Lamb.) Spach. Sometimes called *Cupressus nootkatensis* Lamb.

FAMILY: *Cupressaceae*.

OTHER NAMES : Nootka Sound cypress, Alaska cypress.

DISTRIBUTION. Native to Western North America, where it stretches from Alaska to Oregon. Introduced into Britain about 1853.

THE TREE. Being a comparatively recent introduction to this country, trees are mostly young and small, few exceeding 70–80 ft. in height or 2 ft. in diameter. In North America it reaches 120 ft. and 5–6 ft. in diameter. A handsome tree with pendulous branches which tend to persist in spite of side shade. It is somewhat rare in Britain, being planted for ornamental purposes. Most soils will support growth, even poor gravels and thin soils over limestone. It is also fairly wind-firm, very hardy, probably the hardiest of the cypresses and of fairly rapid growth. Being a shade-bearer it should be planted close to obtain clean timber. It may be raised either from seed or cuttings.

THE TIMBER. Pale yellow in colour, with little demarkation between sapwood and heartwood. It is characterised by a decidedly mealy scent. The texture is fine, slightly finer than timber grown in N. America. It is fairly soft, resembling spruce in this respect, and moderately light (about 28–32 lbs. per cu. ft. when seasoned).

DURABILITY. A very durable timber, even when used in the open ; it is also resistant to timber-destroying insects.

SEASONING. Fairly easy to season, little degrade taking place during drying.

STRENGTH. A strong timber for its weight.

WORKABILITY. Easy to work with most hand and machine tools.

SIZE and AVAILABILITY. As the tree has mostly been planted for ornamental purposes little timber is available. It would be worth growing on a considerably larger scale in Britain, as the timber is of good quality and the tree well adapted to our climate.

USES. First-class joinery, panelling, linings of cupboards and drawers, etc.

HEMLOCK—WESTERN

BOTANICAL NAME : *Tsuga heterophylla* (Raf.) Sarg.

Sometimes known as *Tsuga Albertiana* Sénécl.

FAMILY : *Pinaceae.*

OTHER NAMES : Hemlock, Alaska pine and Hemlock spruce.

Native to the west coast of North America, from S.W. Alaska to British Columbia and N. California. Introduced into Britain in 1851.

THE TREE. In N. America the tree grows to 250 ft. in height and 6–7 ft. in diameter ; although a comparatively recent introduction to this country there are numerous specimens over 100 ft. high and up to 2 ft. 6 ins. in diameter.

A very decorative tree with a spire-like crown. The trunk is exceptionally cylindrical.

It has mostly been planted as an ornamental tree, but there are some plantations, and of recent years it has become more popular as a forest tree.

Being a shade-bearer, it is useful for underplanting larch, Scots pine, etc. ; a good mixture is hemlock, Douglas fir and Western red cedar. It is very adaptable as to soil, growing in most types, from sandy loam to almost stiff clay and also peaty soils. It is best, however, on a deep moist loam and is more suited to the western side of Britain, but will succeed in almost any situation. It is very wind-firm, fairly frost-hardy, and a fast grower.

Although cuttings will strike, it is usually grown from seed and 2 yr. 1 yr. 1 yr. transplants are generally most suitable for planting out.

Bark. The bark is rich in tannin, and supplies two-thirds of the tannin of W.N. America.

TIMBER. The timber is pale brown in colour, with little obvious difference between sapwood and heartwood. The home-grown timber lacks the sheen which is characteristic of imported hemlock.

It is fairly soft (comparable to sitka spruce) with a straight grain and fairly fine texture. Moderately light, weighing about 30 lbs. a cu. ft. when seasoned.

DURABILITY. Not durable, and rather apt to stain. It should always be treated with a preservative when used in the open.

SEASONING. Fairly easy to season. Imported hemlock was formerly sometimes distrusted because of inadequate seasoning in the country of origin ; although a good timber, hemlock is a bad traveller, and wood often arrived discoloured. This can be avoided by quick conversion and drying.

STRENGTH. A fairly strong timber, comparing favourably with Scots pine.

WORKABILITY. Works easily with most hand and machine tools, takes nails well and glues exceptionally well.

SIZE and AVAILABILITY. Up to the present little timber of any size is available, but the recent more extensive planting will result in increasing supplies being available in the future.

It is a tree that would pay to plant more widely especially in mixtures with Douglas fir and Western red cedar.

USES. The timber is suitable for construction, joinery, flooring, panelling, packing cases, boxes, sleepers and also pulp.

HEMLOCK—EASTERN

(*Tsuga canadensis* (L.) Carr.)

This tree should not be confused with the Western hemlock, and its growth is not to be encouraged, as it is slower growing and produces timber that is far inferior.

JUNIPER—COMMON

BOTANICAL NAME : *Juniperus communis* L.

FAMILY : *Pinaceae.*

DISTRIBUTION. This species has a wider distribution than any other tree or shrub. It is found in most parts of Europe, and also as far as India and North America. It is one of the true conifers indigenous to Britain (the others are Scots pine and Yew).

THE TREE. Usually a shrub, it occasionally forms a small tree, up to 40 ft. high. It is common on chalk or limestone hills throughout Britain. It is very slow growing and seldom produces timber of any useful size in this country. Juniper berries are used for flavouring gin and for medicinal purposes.

TIMBER. The sapwood is white ; the heartwood a rich red when first cut, turning brown on exposure. There is frequently irregular formation of heartwood, streaks of sapwood being found within the heartwood. Numerous small knots are characteristic of the wood. It is fairly hard with a compact texture ; the grain is often irregular owing to the fluted trunk. Fairly light in weight, being about 30–34 lbs. per cu. ft. when seasoned.

DURABILITY. Extremely durable, especially the heartwood ; it is also very resistant to insect attack.

SEASONING. Little difficulty should be experienced in seasoning if care be taken.

STRENGTH. A fairly strong wood, but no strength tests have been made.

WORKABILITY. Works excellently with all tools, and is capable of high finish. It glues and veneers well.

SIZE and AVAILABILITY. Juniper is rare in timber sizes, very occasional small trees being felled.

USES. Excellent for linings of wardrobes and cupboards, as it keeps away clothes' moths. It is suitable for pencils if straight-grained and free from knots.

MONKEY PUZZLE

BOTANICAL NAME : *Araucaria araucana* (Mol.) K. Koch.

Formerly the botanical name *Araucaria imbricata* Pav. was used.

FAMILY : *Pinaceae.*

OTHER NAMES : Chile pine.

DISTRIBUTION. Native of Chile and Patagonia, it is one of the few South American trees hardy in Britain. Introduced in 1795, it was not planted commonly until 1844.

THE TREE. In this country the tree grows 50–80 ft. in height and 18 ins. to 2 ft. 6 ins. in diameter. In Chile it reaches 150 ft. and 5 ft. across.

The branches arise in regular whorls and persist to the ground for 50 years or more when under good conditions. There is little taper to the trunk. It is very common as a garden and park tree, but has not been used as a forest tree, although it would probably make a useful timber tree.

It needs a moist soil and climate and prefers a loamy but well-drained soil.

It is wind-fast, although inclined to lose its leading shoot when young. Fairly frost-hardy and with a rapid rate of growth.

Seeds ripen well in England and are the best means of propagation, although terminal shoots may be used as cuttings.

TIMBER. The wood is yellowish-white with little obvious demarkation between sapwood and heartwood. It is fairly soft, but with hard, dark coloured knots in regular whorls. The grain is straight and the texture fine. Weight varies from 30–40 lbs. per cu. ft. when seasoned.

The home-grown timber compares favourably with that grown in Chile, but is usually more knotty.

DURABILITY. Not durable ; should always be treated with a preservative if used in the open.

SEASONING. Usually easy to season.

STRENGTH. A tough timber and with good nail-holding properties. The large number of knots in whorls reduce the strength of larger-sized timbers.

WORKABILITY. Needs care in working, but is capable of a good finish if sharp tools are used.

SIZE and AVAILABILITY. Very little timber is

available as the tree is principally grown for ornament.

USES. In Chile the timber is used for most of the purposes for which European redwood is used in Europe, *e.g.*, building construction, joinery, boxes, etc. It could be used for similar purposes in this country, but is not worth growing in place of Scots pine, as the timber is more knotty and the tree unsuited in appearance to the British countryside.

PINE—MARITIME

BOTANICAL NAME : *Pinus Pinaster* Ait.

Previously called *Pinus maritima* Lam.

FAMILY : *Pinaceae.*

OTHER NAMES : Pinaster, Cluster pine, Bournemouth pine, Seaside pine.

DISTRIBUTION. The tree is native to the Mediterranean region, and is found as far east as Western Asia and south to Algeria. It was introduced into Britain in 1596.

THE TREE. A large tree, up to 90–120 ft. in height and 2–4 ft. in diameter. Older trees are usually clean of branches for two-thirds of their height. There are a few plantations in the South of England, but the tree has not been widely planted, since it is not very hardy in the colder parts of the country. It succeeds, however, excellently in the warmer southern counties and is particularly suitable for planting near the sea. It is valuable for planting sand dunes, and so preventing them from shifting. It prefers a deep sandy soil, and should not be planted in clay nor a limy soil. Essentially a maritime tree, it is unsuitable for inland or high altitudes or exposed situations ; it will, nevertheless, resist strong sea gales and is excellent for shelter belts near the coast.

It demands a considerable amount of light, and is a very fast grower, often adding 2 ft. a year to its height.

Generally speaking, Maritime pine is only worth planting on sand dunes, etc., owing to the inferior quality of its timber.

TIMBER. The sapwood is white to pale yellow and the heartwood light red to reddish-brown. The timber is very inferior in quality, being coarse textured, very resinous and usually knotty. It is fairly hard and heavy (weighing about 33–42 lbs. per cu. ft. when seasoned). The home-grown timber is inferior to that grown in France.

DURABILITY. A moderately durable timber, but needs preservative treatment if used in the open.

SEASONING. Fairly easy to season.

STRENGTH. Rather poor strength values ; it has little elasticity and is generally inferior to Scots pine.

WORKABILITY. Easy to work except where pitch pockets are present.

SIZE and AVAILABILITY. Comparatively little timber is available, but occasional large logs are obtainable.

USES. The main use of Maritime pine is for pit-props ; large numbers were imported into South Wales from France (principally through Bordeaux) before the war ; there is no reason why the tree should not be grown in this country for similar purposes. The timber may also be used for coarse carpentry, inferior building construction, box boards, laths, telegraph and telephone poles, sleepers and paving blocks.

Resin. The most important product of the tree is resin. In Western France (especially Les Landes district) and also in Corsica extensive forests are grown for this purpose. The trees are tapped annually for the resin and some destructive distillation is carried out. The tapping actually improves the quality of the timber, making it harder and more durable. The most important European supplies of rosin and turpentine are obtained from Maritime pine.

PINE—MONTEREY

BOTANICAL NAME : *Pinus radiata* D. Don.

Previously known as *Pinus insignis* Dougl.

FAMILY : *Pinaceae.*

OTHER NAMES : Insignis, Insular pine, Remarkable pine.

DISTRIBUTION. It is native to Monterey county, Cailfornia, where it is restricted to a small area ; it has been planted, however, on a vast scale in such countries as Australia, New Zealand and South Africa. Introduced into Britain in 1833.

THE TREE. It grows to 100 ft. or more in this country, wtih diameters of up to 3 ft.

When grown in the open it branches almost to the ground and is one of the best pines for ornamental planting, especially as its foliage is very green (without the grey tinge characterising most pines). It is one of the few three-needle pines growing in Britain.

Like the Maritime pine, it is mainly a maritime tree, and has mostly been planted near the coast and in the warm southern counties. It has recently been planted more widely, principally because it grows very rapidly—under suitable

conditions as much as 3 ft. a year in height and 2½ ins. diameter.

It succeeds on a sandy soil, even on almost pure sand ; it is wind-firm, and forms a useful shelter especially near the sea.

Planting out is best done with 1 yr. seedlings, and these may be planted at 6 ft. by 6 ft. to obtain clean timber. It is sometimes mixed with *Cupressus macrocarpa*, which appears to form a useful mixture.

This pine is only worth growing where bulk timber is of far greater importance than quality.

TIMBER. Monterey pine is, without doubt, the least valuable of all home-grown softwoods, so far as the quality of the wood is concerned.

The sapwood is white to pale yellow, and fairly wide ; the heartwood is light brown to purplish-brown. The summer wood forms dense lines and makes the timber coarse in texture. The grain is straighter than in most softwoods, and large knots are common. It is fairly soft, and the annual rings are usually very wide, up to 1¼ ins. The weight is about 25–30 lbs. per cu. ft. when seasoned.

DURABILITY. Not durable ; needs preservation if used in the open.

SEASONING. Care is necessary in seasoning to avoid warping.

STRENGTH. A moderately strong wood in most strength categories, though tending to be brittle. The number of large knots reduces the strength of most larger-sized timbers.

WORKABILITY. Fairly easy to work if sharp tools are used.

SIZE and AVAILABILITY. Little mature timber is available, and most trees have been planted for shelter and so are coarse and knotty.

USES. The wood has very limited uses, being only suitable for rough boxes and packing-cases, or estate work if creosoted.

PINE—WEYMOUTH

BOTANICAL NAME : *Pinus Strobus* L.

FAMILY : *Pinaceae*.

OTHER NAMES : The imported timber of this species is known as Yellow pine, Canadian white pine, White pine and Quebec pine.

DISTRIBUTION. It has a wide distribution in Eastern Canada and the U.S.A., stretching from Newfoundland to Georgia, and as far east as Manitoba. It forms very large forests in the Lake States. Introduced in Britain in 1705.

THE TREE. In this country it grows to 60–80 ft. high (occasionally up to 100 ft.) and up to 3 ft. in diameter. In N. America it may be 150 ft. in height, and before the virgin forests were so heavily cut, was commonly 250 ft.

The tree is fairly common in Britain ; a number of small areas were planted at one time because of the fast growth and good quality of the timber. Unfortunately, the ravages of a fungus—the Bark Blister rust (*Cronartuim ribicolor*)—and an insect—the white pine aphis (*Chermes strobi*)—have been very serious, and the tree is not often planted now. It appears to be more suited to the climate of the Continent than of Britain.

It needs a cool climate and a sheltered position to succeed, but is accommodating as to soil, provided it is not too dry. The strong tap-root makes it wind-firm ; it is very hardy and will endure a certain amount of shade when young (up to about 30 years), but needs full light after that. It may be grown pure, or mixed with spruce or beech, or even used to underplant larch or Scots pine.

The tree grows considerably faster than Scots pine and could be grown on a rotation of 40–80 years to obtain useful timber. Seed germinates fairly well, and for planting out 1 yr. 1 yr. or 2 yr. 1 yr. transplants are generally most satisfactory.

The majority of trees are attacked by the Blister rust by the time they are 30 years old. The fungus causing the disease has part of its life cycle on wild currant (*Ribes* spp.), and if this is eliminated from their neighbourhood the trees could be grown successfully.

TIMBER. The sapwood is pale yellow or whitish and narrow ; the heartwood has a pinkish tinge and a distinct sheen ; both these characteristics are more pronounced in the home-grown than in imported *P. Strobus*.

Unlike many other conifers, good quality timber is obtainable from Weymouth pines grown under almost any conditions. The wood is soft, and the texture fine and grain straight. Knots are usually large but sound. Weight is about 24 lbs. per cu. ft. when seasoned.

DURABILITY. Not a durable wood, and should be treated with a preservative if used in the open.

SEASONING. Easy to season ; little degrade taking place.

STRENGTH. It is not an exceptionally strong wood, being very soft and light, and is considerably weaker than Scots pine.

WORKABILITY. Very easy to work, either by hand or machine tools. It can also be carved well. An excellent smooth finish can be obtained. It also takes glue, stain, paint and polish well and has no inclination to split on nailing or screwing.

SIZE and AVAILABILITY. Owing to the diseases affecting the tree (see above), very little mature timber is available : occasionally fairly large logs are obtainable.

USES. Good quality timber ; would be suitable for engineers' patterns and high-class joinery, including panelling (the more knotty timber could well be used for ' knotty pine panelling ', a type that has recently become popular in Canada). Other uses include matches, carving, kitchen fitments, etc.

IMPORTED *P. STROBUS*

The timber imported under the names White pine, Yellow pine, etc., is regarded as one of the best quality softwoods in the world, and commands a very high price.

TREES SUITABLE FOR VARYING CONDITIONS OF SOIL, ASPECT, FROST, SHADE AND WIND

SOILS

TREES MOST SUITABLE FOR :—

POOR SANDY SOILS :
Broad Leaf : Birch, False Acacia.
Conifers : Corsican Pine, Austrian Pine, Weymouth Pine, Scots Pine.

PURE SAND :
Conifers : Austrian and Corsican Pine.

HEAVY CLAY SOILS :
Broad Leaf : Alder, Ash, Elms, Hornbeam, Horse Chestnut, Lime, Oak (except Holm Oak), Poplar, Sweet Chestnut.
Conifers : Lawson's Cypress, Red Cedar, Silver Fir, Sitka Spruce.

ALKALINE SOILS (mainly CHALK and LIMESTONE) :
Broad Leaf : Ash, Beech, Cherry, Hawthorn, Maples, Poplars, Sycamore.

PEAT SOILS :
Conifers : Scots Pine, Sitka and Common Spruce.

TREES REQUIRING :—

WET SOILS : Alder.

MOIST SOILS :
Broad Leaf : Ash, Chestnut, Willow.
Conifers : Douglas Fir, Spruces.

DEEP SOILS :
Broad Leaf : Ash, Lime, Maple, Oak, Sweet Chestnut, Sycamore.
Conifers : Douglas Fir, Larch, Red Cedar, Silver Fir.

TREES SUCCESSFUL ON :—

SHALLOW SOILS :
Broad Leaf : Aspen, Birch.
Conifers : Spruce.

DRY SOILS :
Broad Leaf : Birch, False Acacia.
Conifers : Corsican, Austrian and Scots Pines.

ASPECT

TREES THRIVING BEST WITH :—

NORTH AND EAST ASPECTS :
Broad Leaf : Ash, Beech, Hornbeam.
Conifers : Douglas Fir, Jap Larch, Larch, Silver Fir, Spruce.

SOUTH AND WEST ASPECTS :
Broad Leaf : Chestnut, Elm, Maple, Oak.
Conifers : Austrian and Corsican Pines.

ANY ASPECT :
Broad Leaf : Alder, Aspen, Birch, Hazel, Horse Chestnut, Sycamore.
Conifer : Scots Pine.

FROST HARDINESS

FROST TENDER :
Broad Leaf : Ash, Beech, False Acacia, Holm Oak, Plane, Sweet Chestnut, Tree of Heaven, Walnut.
Conifers : Giant Fir, Monterey Cypress, Silver Fir.

MODERATELY HARDY :
Broad Leaf : Lime, Oaks (except Holm Oak), Sycamore.
Conifers : Cedars (*Cedrus* spp.), Douglas Fir, Himalayan Blue Pine, Jap, Larch (more tender than Common Larch), Larch, Sitka Spruce.

HARDY :
Broad Leaf : Alder, Aspen, Birch, Elms, Hornbeam, Horse Chestnut, Poplars, Willows, Holly, Hazel.
Conifers : Corsican and Austrian Pines, Red Cedar, Scots Pine, Spruce, Wellingtonia, Weymouth Pine, Yew.

SHADE ENDURED

LIGHT DEMANDERS :
Broad Leaf : Ash, Birch, Elms, False Acacia, Horse Chestnut, Oaks, Plane, Poplars, Sweet Chestnut (shade bearer up to 20 years), Tree of Heaven, Walnut, Willow.
Conifers : Cedars (*Cedrus* spp.), Himalayan Blue Pine, Larch, Scots Pine, Wellingtonia.

MODERATE SHADE BEARERS :
Broad Leaf : Alder, Hazel, Lime, Sycamore.
Conifers : Austrian and Corsican Pine, Weymouth Pine.

SHADE BEARERS :
Broad Leaf : Beech, Holly, Hornbeam.
Conifers : Douglas Fir, Giant Fir, Red Cedar, Monterey Cypress, Silver Fir, Sitka Spruce, Spruce, Yew.

WIND FIRMNESS

WIND FIRM TREES :
Broad Leaf : Ash, Birch, Chestnut, False Acacia, Holly, Hornbeam, Horse Chestnut, Oak, Plane, Poplars, Sycamore.
All listed *Conifers* except : Common and Sitka Spruce, Douglas Fir, Monterey Cypress.

MODERATELY WIND-FIRM TREES :
Broad Leaf : Alder, Aspen, Beech, Lime, Willows.

TREES APT TO BE BLOWN :
Broad Leaf : Common Elm.
Conifers : Monterey Cypress (when young), Douglas Fir, Common and Sitka Spruce.

TREES SUFFERING FROM WIND-BREAK AND SNOW-BREAK :
Broad Leaf : Elm, Horse Chestnut, Willows.
Conifers : Cedars (*Cedrus* spp.), Silver Fir.

NOTE ON SHELTER BELT :

Trees used for shelter-belts should be planted wide apart, at least 15 ft. Austrian Pine is one of the best trees for the outside of the belt, and Corsican Pine, Beech, and Sycamore for the mixture within.

APPENDIX II

KILN SCHEDULES

Reproduced from ' A Handbook of Home-Grown Timbers,' by the Forest Products Research Laboratory, with permission of the Controller of H.M. Stationery Office.

It must be emphasised that these schedules are approximate only and represent conditions suitable for average qualities of timber intended for normal use. Experience with timber from particular sources of supply destined for specific purposes will generally enable necessary modifications to be made.
The schedules are designed for use with timber up to about 1½ ins. thick.

SCHEDULE I

This is a special low temperature schedule suitable for timbers which must not darken in drying, and for those which have a pronounced tendency to warp.

Moisture content (%) of the wettest timber on the air-inlet side at which changes are to be made	Temperature				Relative Humidity
	Dry Bulb		Wet Bulb		
	° F.	° C.	° F.	° C.	%
Green	105	40·5	99	37·2	80
60	105	40·5	97	36·3	75
40	110	43·3	100	37·9	70
35	110	43·3	98	36·9	65
30	110	43·3	96	35·9	60
25	115	46·1	99	37·2	55
20	115	46·1	96	36·1	50
16	120	48·8	98	36·9	45
14	120	48·8	96	35·5	40

SCHEDULE II

This schedule is intended for use with timbers which dry very slowly, but which are not particularly prone to warping.

Moisture content (%) of the wettest timber on the air-inlet side at which changes are to be made	Temperature				Relative Humidity
	Dry Bulb		Wet Bulb		
	° F.	° C.	° F.	° C.	%
Green	120	48·8	115	46·0	85
60	125	51·7	118	47·9	80
40	130	54·4	123	50·4	80
35	140	60·0	132	55·8	80
30	150	65·6	140	59·8	75
25	160	71·1	149	65·0	75
20	170	76·6	156	68·8	70
16	180	82·2	162	72·4	65
14	180	82·2	159	70·7	60

SCHEDULE III

This schedule is the mildest of them all, and cannot be expected to produce rapid drying. It is, therefore, of use with refractory timbers.

Moisture content (%) of the wettest timber on the air-inlet side at which changes are to be made	Temperature				Relative Humidity
	Dry Bulb		Wet Bulb		
	° F.	° C.	° F.	° C.	%
Green	105	40·5	101	38·0	85
60	105	40·5	99	37·2	80
40	110	43·3	102	38·7	75
35	110	43·3	100	37·9	70
30	115	46·1	103	39·5	65
25	120	48·8	105	40·8	60
20	125	51·7	107	42·0	55
16	130	54·4	109	43·0	50
14	135	57·2	111	43·8	45

SCHEDULE IV

Moisture content (%) of the wettest timber on the air-inlet side at which changes are to be made	Temperature				Relative Humidity
	Dry Bulb		Wet Bulb		
	° F.	° C.	° F.	° C.	%
Green	110	43·3	105	40·8	85
60	110	43·3	104	39·9	80
40	115	46·1	107	41·5	75
35	115	46·1	105	40·5	70
30	120	48·8	108	42·0	65
25	125	51·7	110	43·3	60
20	130	54·4	112	44·4	55
16	135	57·2	113	45·4	50
14	145	62·8	116	46·7	40

SCHEDULE V

Moisture content (%) of the wettest timber on the air-inlet side at which changes are to be made	Temperature				Relative Humidity
	Dry Bulb		Wet Bulb		
	° F.	° C.	° F.	° C.	%
Green	120	48·8	115	46·0	85
60	120	48·8	113	45·0	80
40	125	51·7	116	46·8	75
35	125	51·7	114	45·7	70
30	130	54·4	116	47·0	65
25	135	57·2	118	48·2	60
20	140	60·0	120	49·2	55
16	145	62·8	122	50·1	50
14	155	68·3	124	51·2	40

SCHEDULE VI

Moisture content (%) of the wettest timber on the air-inlet side at which changes are to be made	Temperature				Relative Humidity
	Dry Bulb		Wet Bulb		
	° F.	° C.	° F.	° C.	%
Green	130	54·4	123	50·4	80
35	135	57·2	123	50·7	70
30	140	60·0	125	52·1	65
25	145	62·8	127	53·1	60
20	155	68·3	131	54·9	50
15	165	73·9	132	55·8	40

SCHEDULE VII

Moisture content (%) of the wettest timber on the air-inlet side at which changes are to be made	Temperature				Relative Humidity
	Dry Bulb		Wet Bulb		
	° F.	° C.	° F.	° C.	%
Green	140	60·0	133	55·8	80
40	145	62·8	132	55·9	70
25	155	68·3	136	58·1	60
20	165	73·9	139	59·7	50
15	175	79·5	140	60·5	40

SCHEDULE VIII

Moisture content (%) of the wettest timber on the air-inlet side at which changes are to be made	Temperature				Relative Humidity
	Dry Bulb		Wet Bulb		
	° F.	° C.	° F.	° C.	%
Green	150	65·6	142	61·1	80
40	160	71·1	146	63·7	70
25	170	76·7	150	65·7	60
20	180	82·2	152	66·9	50
15	185	85·0	148	65·0	40

APPENDIX III

MECHANICAL AND PHYSICAL PROPERTIES OF HOME-GROWN TIMBERS

Reproduced from a ' Handbook of Home-Grown Timbers ' by the Forest Products Research Laboratory by permission of the Controller of H.M. Stationery Office.

Standard Name	Botanical Species	Seasoning	Moisture Content	Weight per cu. ft.		Shrinkage		Static Bending			Impact			Compression	Hardness		Shear	Cleavage	
				At 50% Mois. Cont.	At 12% Mois. Cont.	Green to 12% Mois. Cont.		Maximum Bending Strength	Stiffness	Energy Consumed to Total Fracture	Resistance to Suddenly Applied Loads			Maximum Compressive Strength Parallel to Grain	Resistance to Indentation		Maximum Shearing Strength Parallel to Grain	Resistance to Splitting	
						Radial.	Tang.	Equivalent Fibre Stress at Maximum Load	Apparent Modulus of Elasticity	Total Work	Maximum Height of Drop of 50 lb. Hammer	*Toughness. Energy Consumed	Izod Notched Bar Test. Energy Consumed		On Side Grain	On End Grain		In Radial Plane	In Tangential Plane
			%	lb.	lb.	%	%	lb. per sq. in.	1,000 lb. per sq. in.	in.-lb. per cu. in.	in.	in.-lb.	ft.-lb.	lb. per sq. in..	lb.	lb.	lb. per sq. in.	lb. per in. width	lb. per. in. width
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
HARDWOODS																			
¶Acacia	*Robinia pseudo-acacia*	Green	60	48	—	1·5	2·3	8700	1250	33·8	30	132	4·3	3880	1040	1120	1330	440	500
		Air-dried	**12**	—	**38**	—	—	**13400**	**1360**	**41·5**	**39**	**154**	**8·3**	**6490**	**1120**	**1360**	**1810**	**430**	**520**
Alder	*Alnus glutinosa*	Green	94	39	—	2·2	4·7	6700	1170	20·1	25	104	6·7	3020	500	600	810	240	290
		Air-dried	**12**	—	**32**	—	—	**11000**	**1360**	**15·7**	**25**	**101**	**6·0**	**5740**	**660**	**960**	**1560**	**330**	**390**
Ash	*Fraxinus excelsior*	Green	47	51	—	2·9	7·6	8900	1500	45·2	50	—	—	3750	920	1020	1180	360	460
		Air-dried	**12**	—	**42**	—	—	**15100**	**1860**	**41·8**	**43**	—	—	**6990**	**1490**	**1760**	**1930**	**620**	**660**
Beech	*Fagus sylvatica*	Green	88	52	—	2·8	7·6	8900	1520	26·3	36	119	6·9	3860	960	1080	1210	400	580
		Air-dried	**12**	—	**43**	—	—	**16200**	**1950**	**27·4**	**45**	**151**	**10·6**	**7870**	**1440**	**1820**	**2030**	**430**	**620**
Birch	*Betula pubescens* *Betula pendula*	Green	76	49	—	3·9	6·9	8600	1540	35·6	30‡	135	8·0‡	3680	720	760	980	330	360
		Air-dried	**12**	—	**41**	—	—	**16900‡**	**2060‡**	**29·6‡**	**41‡**	**198**	**14·7**	**8370**	**1230**	**1310**	**2080**	**480**	**520**

Cherry	*Prunus avium*	Green	77	47	—	2·4	6·9	8800	1280	44·3	41‡	218	12·2	3880	930	1030	1180	370	470
		Air-dried	12	—	39	—	—	15100‡	1580‡	30·2‡	43‡	175‡	—	7620	1300	1630	2110	470	620
Chestnut, Sweet	*Castanea sativa*	Green	124	41	—	1·6	3·7	7200	1110	18·1	26	87	5·9	3380	710	790	960	290	330
		Air-dried	12	—	32	—	—	10900	1270	8·3	33	77	6·3	6200	690	1080	1350	330	360
Elm	*Ulmus procera*	Green	140	40	—	2·6	4·9	5500	810	13·9	26	70	3·6	2360	760	800	1020	330	380
		Air-dried	12	—	32	—	—	9300	1090	14·0	33	68	4·5	4740	820	1040	1610	350	420
Elm, Dutch	*Ulmus hollandica*	Green	139	40	—	2·7	4·9	6100	830	19·8	32	115	5·6	2610	760	790	970	330	380
		Air-dried	12	—	32	—	—	10200	1110	19·2	28	96	6·3	4750	870	1100	1490	350	420
Elm, Wych	*Ulmus glabra*	Green	75	47	—	2·7	7·0	9400	1450	25·1	32	117	6·1	4250	890	970	1060	400	460
		Air-dried	12	—	38	—	—	14500	1640	32·4	43	144	9·8	6870	1010	1350	1650	510	610
Hornbeam	*Carpinus betulus*	Green	71	54	—	3·0	6·6	9100	1490	52·3	50	—	—	3770	1230	1270	1260	440	580
		Air-dried	12	—	46	—	—	16400	1850	26·7‡	45	166	—	7690	1570	1930	2260	520	790
Lime	*Tilia vulgaris*	Green	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		Air-dried	12	—	39	—	—	14600§	1700§	—	—	120	—	6830§	920§	—	—	490(§)	680(§)
Oak	*Quercus robur* *Quercus petræa*	Green	89	52	—	2·6	7·5	8100	1290	20·4	34	144	7·8	3850	1050	1120	1170	390	470
		Air-dried	12	—	43	—	—	13300	1560	19·1	33	131	8·7	7210	1230	1460	1760	360	500
Plane, London	*Platanus acerifolia*	Green	87	49	—	2·1	6·1	7500	990	32·1	49‡	219	12·4	3380	960	1040	1240	410	630
		Air-dried	12	—	40	—	—	12400§	1120§	—	40‡	—	—	5820	1270	1490	1810‡	380‡	650‡
Poplar, Black Italian	*Populus serotina*	Green	153	33	—	1·9	6·2	5700	1060	24·0	24	101	5·4	2700	460	480	750	210	270
		Air-dried	12	—	27	—	—	9900	1340	16·4	22	90	6·1	5230	500	740	1130	260	330
Poplar, Grey	*Populus canescens*	Green	102	36	—	2·3	6·5	6100	1110	19·2	20	111	7·6	2810	390	470	750	210	300
		Air-dried	12	—	30	—	—	10400	1470	19·2	24	107	8·1	5150	530	770	1350	310	390
Sycamore	*Acer pseudoplatanus*	Green	69	45	—	2·1	4·4	9000	1300	25·8	29	120	6·9	3840	860	990	1280	390	520
		Air-dried	12	—	35	—	—	13000	1460	18·7	33	102	5·5	6730	1090	1510	2190	420	680
Whitebeam	*Sorbus aria*	Green	73	58	—	—	—	—	—	—	—	387	—	3780	1180	1200	—	530	620
		Air-dried	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Wild Service	*Sorbus torminalis*	Green	71	52	—	—	—	—	—	—	—	—	—	3270§	990§	—	—	490‡§	600‡ §
		Air-dried	12	—	44	—	—	—	—	—	—	—	—	6720§	1450§	—	—	—	910 §

* Blow tangential, i.e. on radial face.
‡ Figures derived from five tests or less.
§ Figures derived from substandard test pieces.
¶ This species is generally known as Acacia, but the British standard name is Robina.

APPENDIX III—*Continued*

MECHANICAL AND PHYSICAL PROPERTIES OF HOME-GROWN TIMBERS—*Continued*

Standard Name	Botanical Species	Seasoning	Moisture Content	Weight per cu. ft.		Shrinkage		Static Bending			Impact			Compression	Hardness		Shear	Cleavage	
				At 50 % Mois. Cont.	At 12 % Mois. Cont.	Green to 12% Mois. Cont.		Maximum Bending Strength	Stiffness	Energy Consumed to Total Fracture	Resistance to Suddenly Applied Loads			Maximum Compressive Strength Parallel to Grain	Resistance to Indentation		Maximum Shearing Strength Parallel to Grain	Resistance to Splitting	
						Radial	Tang.	Equivalent Fibre Stress at Maximum Load	Apparent Modulus of Elasticity	Total Work	Maximum Height of Drop of 50 lb. Hammer	*Toughness. Energy Consumed	Izod Notched Bar Test. Energy Consumed		On Side Grain	On End Grain		In Radial Plane	In Tangential Plane
			%	lb.	lb.	%	%	lb. per sq. in.	1,000 lb. per sq. in.	in. lb. per cu. in.	in.	in.-lb.	ft.-lb.	lb. per sq. in.	lb.	lb.	lb.per sq. in.	lb. per in. width	lb. per in. width
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
HARDWOODS *Continued.*																			
Willow, Crack	*Salix fragilis*	Green	101	33	—	1·0	4·9	4800	870	36·4	34	—	—	2070	430	410	620	240‡	280‡
		Air-dried	**12**	—	**27**	—	—	**9000**	**1080**	**28·4‡**	**29‡**	—	—	**3930**	**650**	**790**	**1070**	**290**	**380**
Willow, Cricket bat	*Salix alba* var. *cærulea*	Green	90	32	—	1·2	6·2	4300	870	33·4‡	38‡	—	—	1900	410	390	570	190	270
		Air-dried	**12**	—	**26**	—	—	**8500‡**	**1030‡**	**36·2‡**	**29‡**	—	—	**3810**	**580**	**710**	**1030‡**	**280**	**400**
Willow, White	*Salix viridis*	Green	113	33	—	1·5	6·8	4900	740	35·2	36	183	9·2	2050	460	470	660	230	300
		Air-dried	**12**	—	**27**	—	—	**8600**	**900**	**33·3**	**30**	**129**	**7·8**	**3970**	**540**	**710**	**1210**	**310**	**390**
SOFTWOODS																			
Cedar, Port Orford	*Chamæcyparis lawsoniana*	Green	143	31	—	—	—	4700§	610§	—	—	200	—	1990§	380§	—	670§	200§	240§
		Air-dried	**12**	—	**26**	—	—	**9300§**	**840§**	—	—	**98**	—	**4010§**	**590§**	—	**1380§**	**280§**	**300§**
Fir, Douglas	*Pseudotsuga taxifolia*	Green	61	38	—	2·2	3·8	7200	1320	23·9	27	—	—	3340	500	620	89	210	250
		Air-dried	**12**	—	**30**	—	—	**12000**	**1640**	**21·3**	**27**	—	—	**6590**	**760**	**1000**	**1390**	**220**	**260**

Fir, Silver	*Abies alba*	Green	100	36	—	1·7	4·6	5900	1250	15·9	22	99	—	3070	430	520	740	190	230
		Air-dried	**12**	—	**28**	—	—	**10900**	**1520**	**20·3**	**25**	—	—	**5910**	**640**	**920**	**1240**	**190**	**250**
Larch, European	*Larix decidua*	Green	50	44	—	1·6	4·3	7300	1130	36·1	35	158	7·9	3480	530	610	890	220	240
		Air-dried	**12**	—	**34**	—	—	**12700**	**1480**	**22·4**	**29**	**78**	**4·3**	**6920**	**840**	**1050**	**1520**	**230**	**270**
Larch, Japanese	*Larix kæmpferi*	Green	49	38	—	1·1	4·3	6000	920	34·1	29	128	10·6	2820	420	530	770	200	230
		Air-dried	**12**	—	**30**	—	—	**11900**	**1190**	**21·4**	**30**	**79**	**4·6**	**6450**	**610**	**820**	**1490**	**190**	**250**
Pine, Corsican	*Pinus nigra* var. *calabrica*	Green	150	38	—	2·0	4·6	5400	1080	14·3	20	105	6·4	2680	440	470	720	210	240
		Air-dried	**12**	—	**30**	—	—	**10800**	**1410**	**13·1**	**22**	**61**	**3·9**	**5890**	**670**	**810**	**1390**	**230**	**320**
Pine, Scots	*Pinus sylvestris*	Green	79	41	—	2·3	4·8	6000	1240	25·4	26	145	9·2	3020	440	450	750	210	220
		Air-dried	**12**	—	**32**	—	—	**12000**	**1590**	**19·0**	**31**	**116**	**5·4**	**6640**	**680**	**800**	**1400**	**260**	**330**
Spruce, European	*Picea abies*	Green	81	34	—	1·7	4·6	5300	1070	13·6	19	62	4·6	2610	340	410	620	180	200
		Air-dried	**12**	—	**27**	—	—	**10400**	**1380**	**20·2**	**26**	**53**	**2·7**	**5670**	**480**	**720**	**1170**	**240**	**280**
Spruce, Sitka	*Picea sitchensis*	Green	62	30	—	1·8	3·9	4800	880	19·4	21	102	5·7	2290	350	400	560	150	190
		Air-dried	**12**	—	**24**	—	—	**8800**	**1250**	**15·2**	**20**	**51**	**3·6**	**4690**	**480**	**760**	**1050**	**180**	**230**
Yew	*Taxus baccata*	Green	110	52	—	—	—	—	—	—	—	125	—	4870§	1400§	1240‡§	—	—	520§
		Air-dried	—	—	**38**	—	—	—	—	—	—	—	—	**7950§**	**1120§**	—	—	**310‡§**	**400***
Redwood	*Pinus sylvestris*	Green	—	40	—	2·1	4·4	6500	1240	—	26	—	—	3140	430	450	790	190	180
		Air-dried	**12**	—	**30**	—	—	**11200**	**1420**	—	**24**	**70**	—	**6360**	**550**	**740**	**1320**	**230**	**250**

* Blow tangential, i.e. on a radial face.
‡ Figures derived from five tests or less.
§ Figures derived from substandard test pieces.

APPENDIX IV

NOTES ON THE FUEL VALUE OF BRITISH TIMBERS

Wood is undoubtedly the oldest form of fuel in the world and, although it has less heating value per pound weight than coal, it has certain advantages, *e.g.*, cleanliness, fragrance, property of wood ash to " keep in " all night, etc.

There is a considerable variation in the value of different timbers for fuel, and also a variation according to condition, density and part of the tree from which the wood is taken. Generally, the denser the wood, the better its heating value and the longer it burns : heartwood is usually better than sapwood and seasoned wood better than freshly felled. Decayed wood is almost useless as firewood, and logs should be stored so that they keep reasonably dry, to prevent rot.

Burning wood in logs, in place of coal, requires wood of a different type from that used for kindling ; the latter is best made from softwoods such as larch or Scots pine (London plane is also excellent for the purpose). For logs, hardwoods are best ; softwoods burn fiercely, but quickly, and tend to throw out sparks. The following notes give briefly the fuel characteristics of the more common British timbers.

ALDER : poor heating properties, even when dry.

ASH : one of the best fuel woods, either wet or dry : good heating properties : burns rapidly.

BEECH : rather better even than ash : should be burned dry.

BIRCH : has good heating properties and burns freely, especially when dry.

CEDAR OF LEBANON : gives off a fragrant odour but has only low heating properties.

CHERRY : Rather fragrant and burns well when dry, somewhat difficult to ignite.

CHESTNUT (SWEET) : one of the poorest fuel woods, tends to smoulder.

CYPRESSES : although these do not have very good heating properties, they are very fragrant (especially Lawson's Cypress).

ELM : when dry and fully ignited is a good fuel wood, but tends to smoulder if at all wet.

HAWTHORN : excellent : burns hotly and lasts well : may be used green or dry.

HORNBEAM : a first class fuel wood : gives an intense heat and lasts well.

HORSE CHESTNUT : very poor : has low heating properties.

LARCH : to be avoided in the form of logs as it throws out dangerous sparks, and gives little heat. It is valued as kindling.

LIME : very poor : tends to smoulder : gives little heat and is difficult to ignite.

MAPLE : gives a good heat, but is not in the first rank : should be dry.

OAK : excellent for heating value and lasting qualities : dry heartwood is best. The smoke tends to be irritating to the throat.

PEAR (and APPLE) : both have high heating properties and last well : apple especially is fragrant.

PINES : burn too quickly and spark too freely to be good in the form of logs : useful as kindling.

PLANE : first class wood, when obtainable : gives a good heat and lasts well, either green or seasoned. Excellent as kindling.

POPLARS : poor : tend to smoulder and give little heat.

SPRUCE : very poor : sparks dangerously and, in logs, tends to smoulder.

SYCAMORE : burns well and gives a good heat : should be dry.

WILLOW : very poor : has low heating properties and tends to smoulder.

YEW : Yew, when seasoned, is perhaps the best of our fuel woods : gives an intense heat and lasts extremely well, but tends to splutter and throws out sparks.

When burning logs in an open grate, it is important that a reasonably brisk fire should be kept up. The country saying, " One log can't burn ; two logs won't burn ; three logs *will* burn, and four logs make a good fire," is both practically and scientifically sound.

If wood is burned over a long period, there is a danger that a tarry deposit will be formed on the walls of the chimney, which may result in chimney fires. To obviate this, the chimney should be scraped by the sweep periodically—once a year would suffice.

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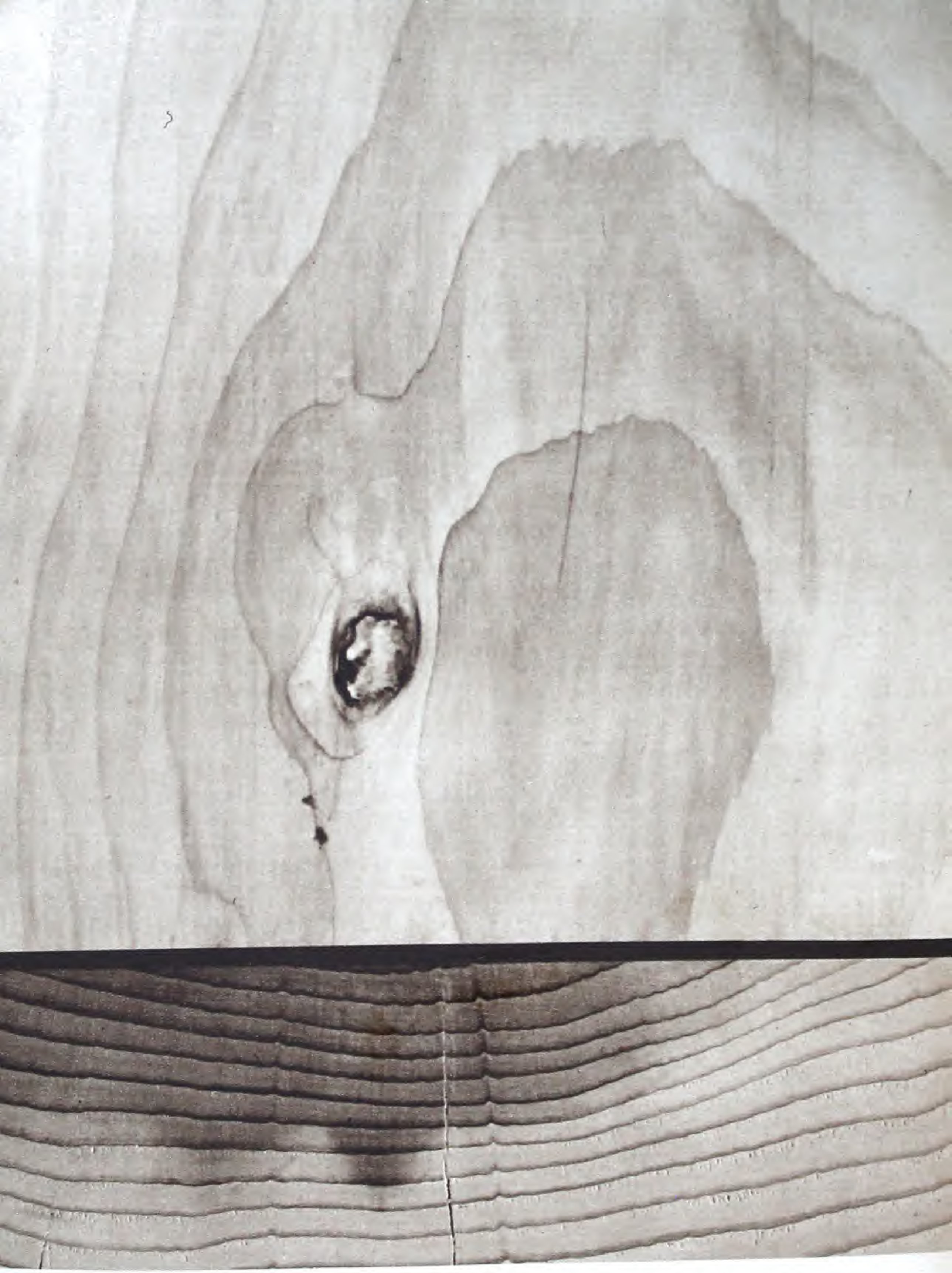

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